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(54) **METHOD AND APPARATUS FOR ELIMINATING REGISTER BOXES, IMPROVING PENETRATION SEALING, IMPROVING AIRFLOW AND REDUCING THE LABOR COSTS TO INSTALL CEILING REGISTERS**

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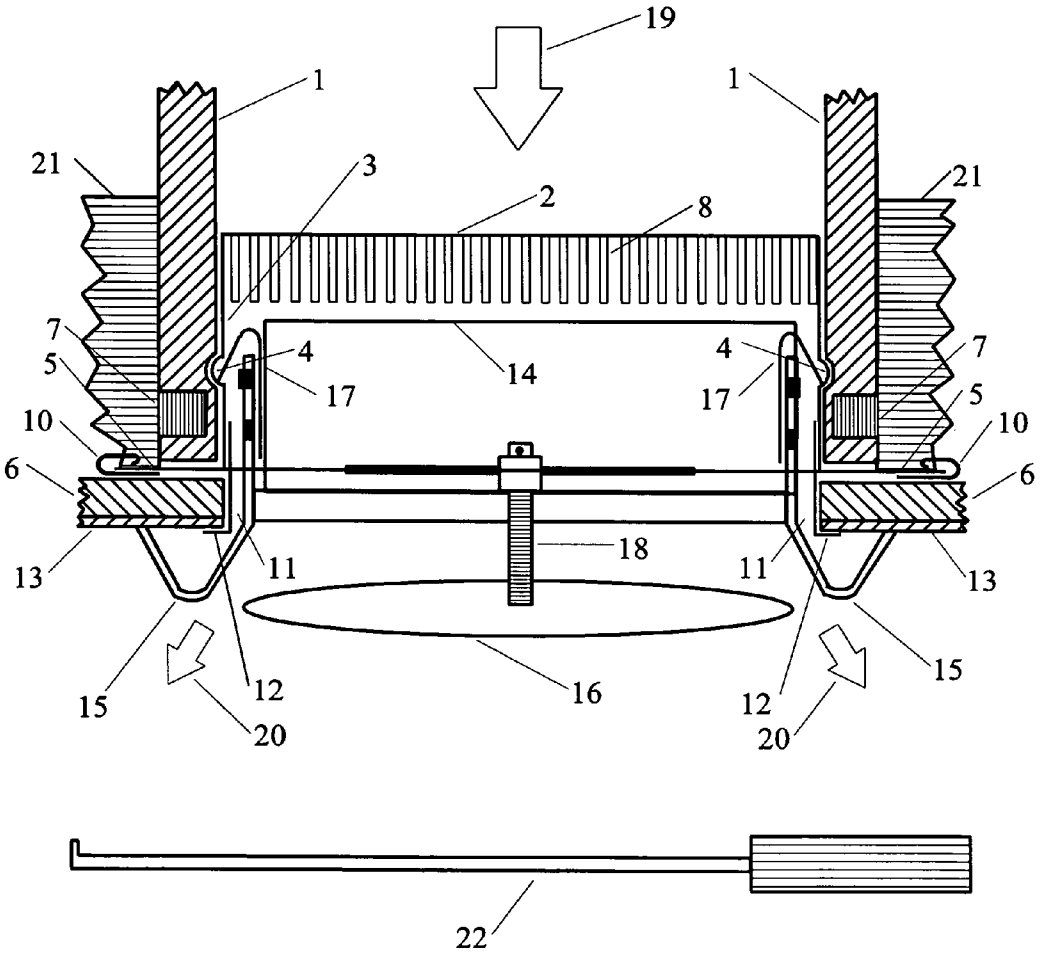
(57) **ABSTRACT**

A method and apparatus for eliminating register boxes, improving penetration sealing, improving airflow and reducing the labor costs to install ceiling registers is disclosed. A collar plate assembly that interfaces with flexible or metal air ducts is provided with at least one spring indentation ring in the collar portion of the assembly to accept two or more locking springs. These locking springs are used to attach the ceiling register to the collar plate assembly. The collar plate assembly uses mounting rails that attach the assembly to either ceiling or wall supports. After the ceiling or wall material is applied, the circular area inside the collar is cut-out to provide access. A trim ring is inserted in the cut-out that attaches between the collar and the ceiling or wall to eliminate air leakage and provide an essentially smooth flow of air from the supply duct into the inside of the structure. After ceiling or wall installation and surface preparation is completed, the ceiling register is simply positioned over the register cut-out and firmly inserted until it seals against the ceiling or wall surface. The ceiling register is locked into place by the action of its locking springs expanding into the collar indentation ring. No ceiling register mounting hardware is required.



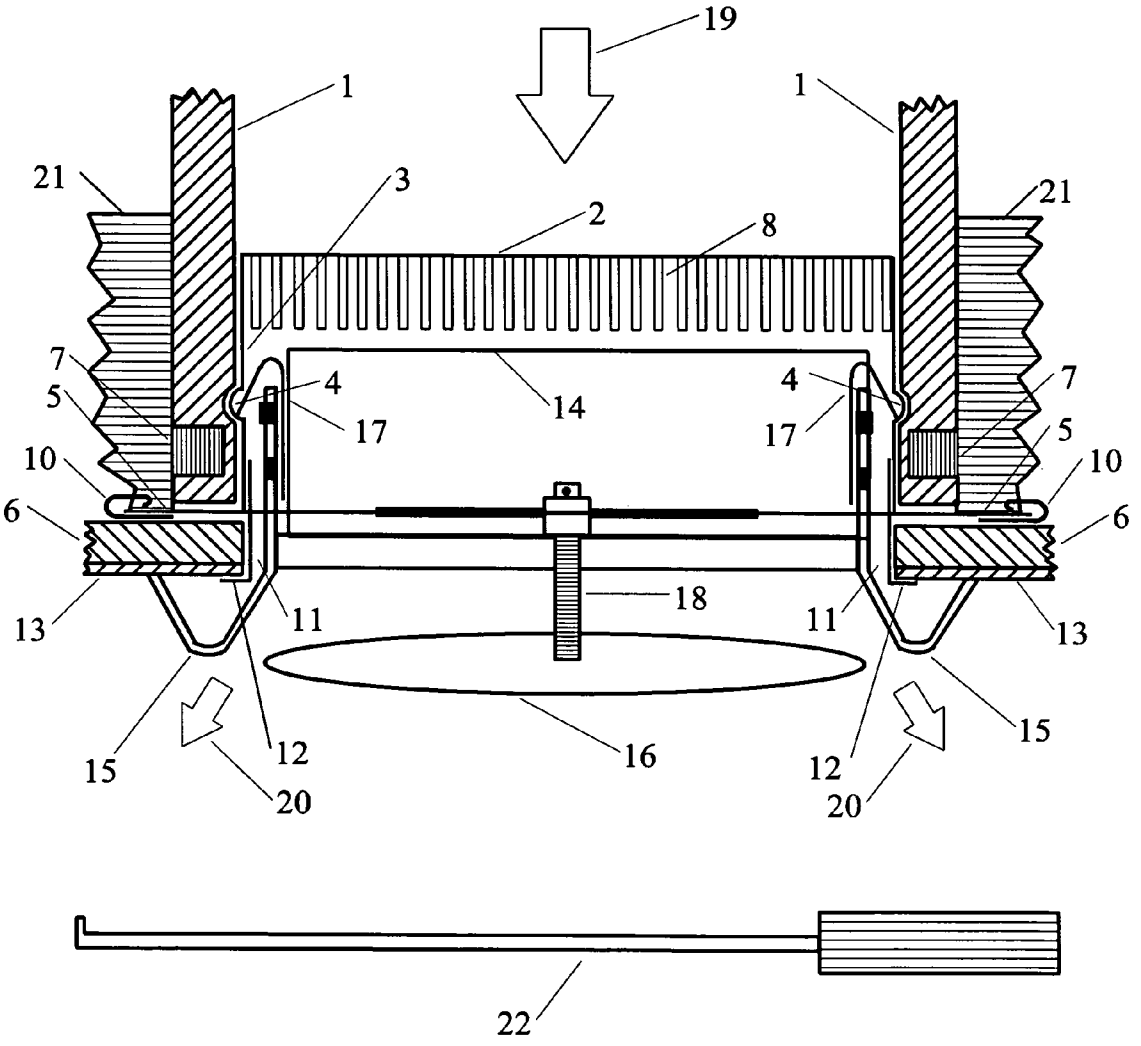

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FIGURE 1

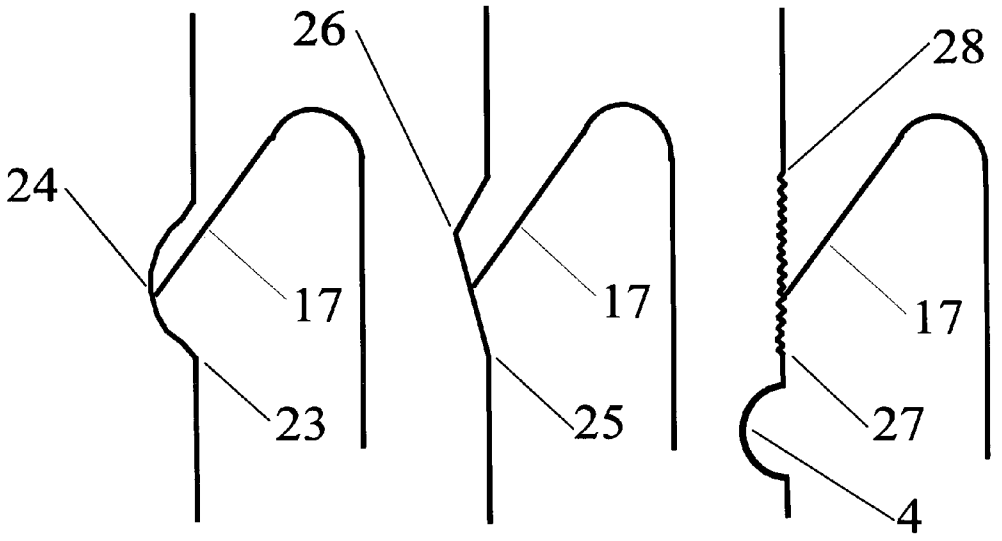

FIGURE 2

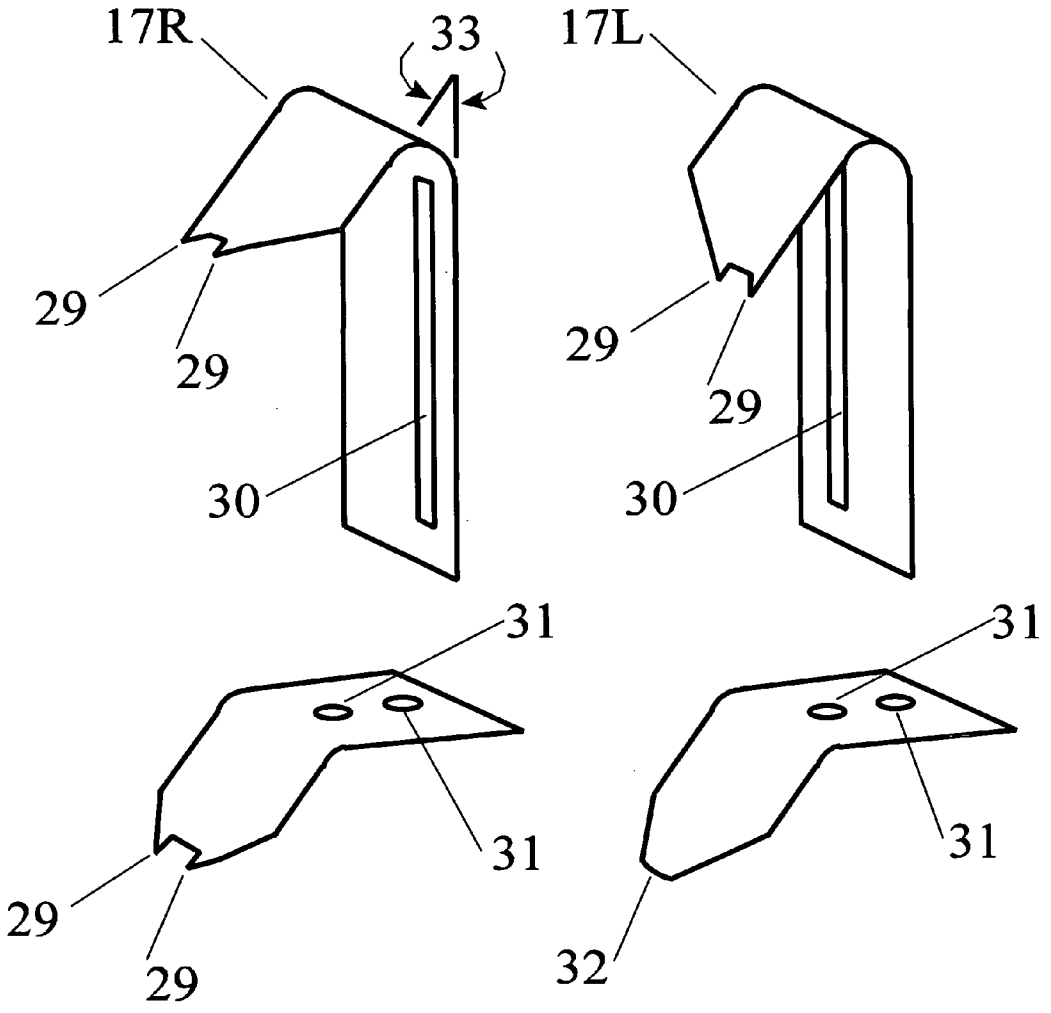

FIGURE 3

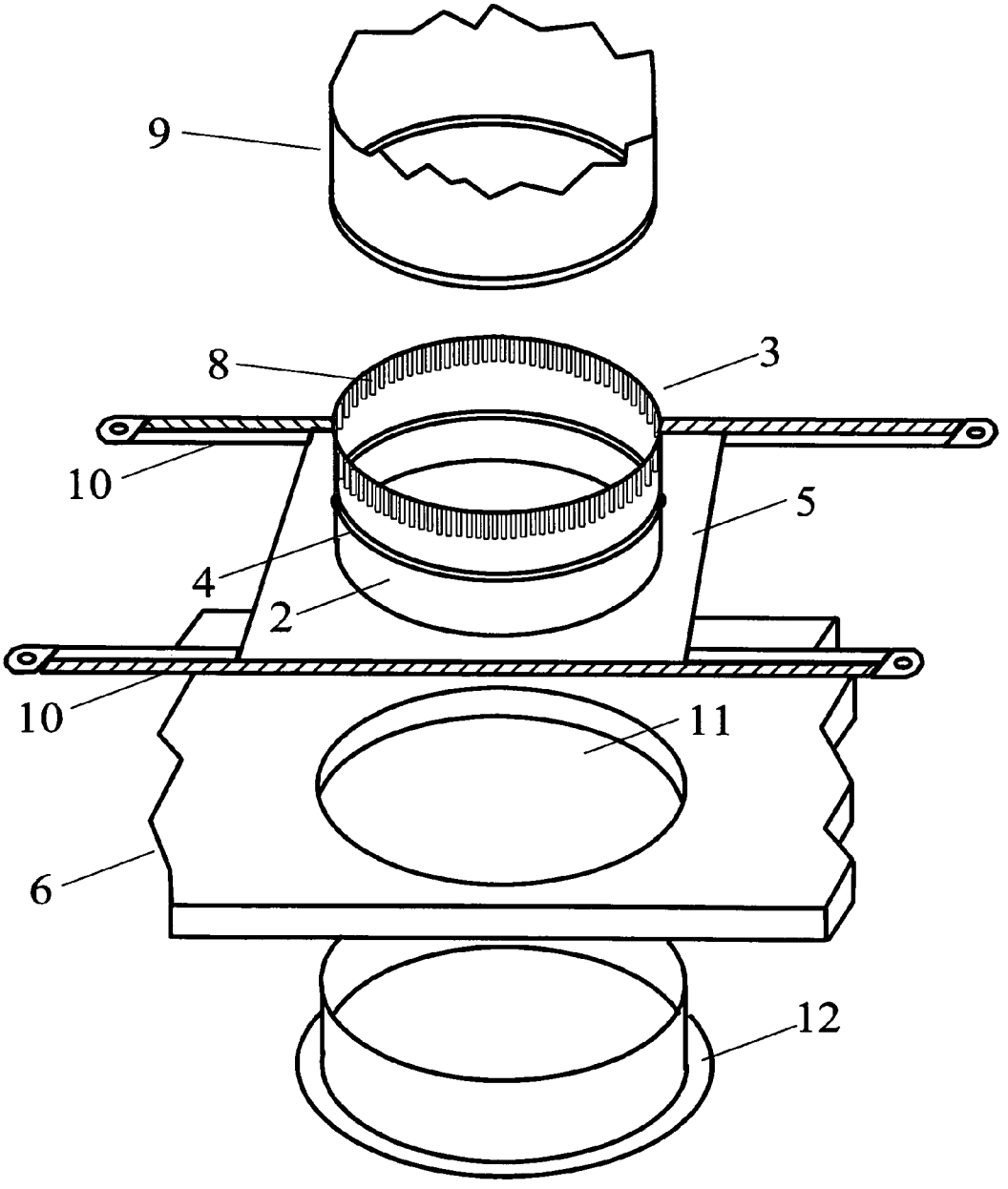

FIGURE 4

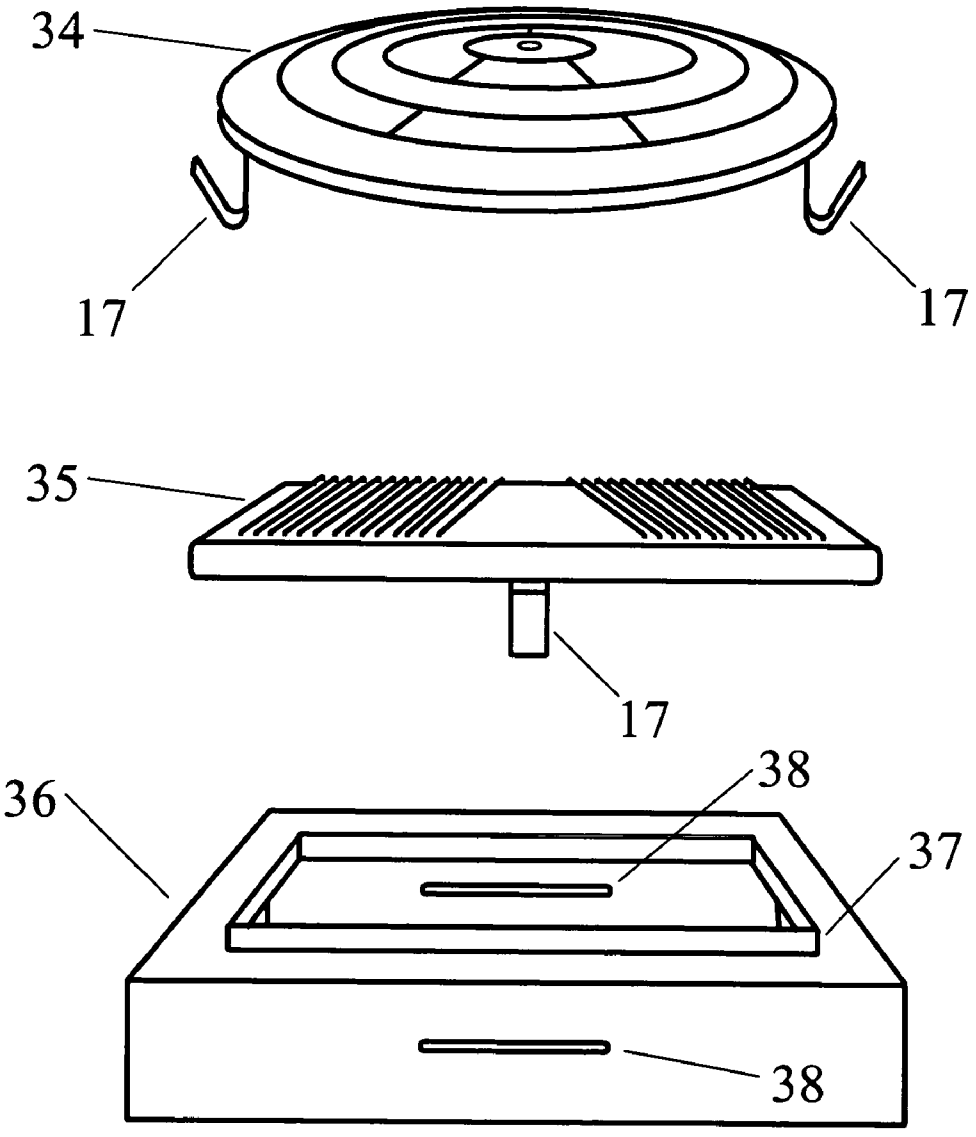

FIGURE 5

METHOD AND APPARATUS FOR ELIMINATING REGISTER BOXES, IMPROVING PENETRATION SEALING, IMPROVING AIRFLOW AND REDUCING THE LABOR COSTS TO INSTALL CEILING REGISTERS

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention pertains in general to a method and apparatus for eliminating heating, ventilation, and air conditioning (HVAC) system register boxes, improving penetration sealing, improving airflow and reducing the labor costs to install ceiling registers in a structure, and more precisely, to a method and apparatus for eliminating HVAC system register boxes, improving penetration sealing, improving airflow and reducing the labor costs to install ceiling registers in a structure using mechanical methods.

BACKGROUND OF THE INVENTION

[0002] Eliminating leakage in air ducts, register boxes, ceiling registers, return plenum components and associated mechanical parts, including penetrations of ceilings and walls, is a paramount issue in the heating, ventilation and air conditioning (HVAC) industry. The importance is derived from the need to improve energy efficiency. Unfortunately, the quest to seal the myriad of mechanical joints in such systems have caused substantial increases in labor and material costs. One manufacturer (M&M Manufacturing Company, Fort Worth, Tex.) has produced a ceiling register box (DucTite®) which is made of a single piece of metal in an attempt to provide a substantially sealed unit. Although such products do provide for reductions in leakage, their added costs have proven to be a substantial barrier to widespread use.

[0003] There is also some confusion about the roles of sealing. A key goal is to stop leaks at their source using appropriate sealing compounds or designs that eliminate leakage paths. These leakage paths include every mechanical joint in the entire system as well as the areas where register boxes penetrate ceilings and walls. Local building codes generally provide for the incorporation of a gasket or the application of an appropriate gasket material to reduce leakage between the ceiling or wall and the ceiling register flange. The area inside these register flanges is cut out of the ceiling or wall material so that the edges of the register box can protrude into the interior space. Such cuts are made from the blind side of the ceiling or wall and they are made on the outside of the register flanges. The circular cutting tools used to make these cuts often leave debris in and around these flanges and provide a convenient location for air leaks between the interior of the room and the attic or wall space. An optimum shape for these ceiling and wall penetrations is round rather than rectangular because the cutting can proceed more quickly and there is no tendencies to cut outside the desired path at corners. Since cutting is done from the blind side of the ceiling or wall, control of the cutting path is optimized if it can be done inside a round shape rather than outside a rectangular shape. Whether the cut is round, square or rectangular, there is still a significant issue about how to provide a reliable seal between the ceiling or wall surface and the air duct. A reliable mechanical joint is needed that secures the ceiling or wall surface to the air duct.

[0004] Compounding these sealing issues is the need to properly insulate all such components once they are sealed. In many cases there is a mixture of round objects such as air ducts and square or rectangular objects such as ceiling register boxes. The latter require flat sheets of insulation material to be applied to the outside or the inside of these boxes. These insulation materials often cover up the mechanical joints and make it very difficult to perform a proper inspection of the duct work system. Single story register boxes are typically about five and a half inches tall, which is close to the thickness of the insulation material installed in an attic or wall. As such, the attic or wall insulation offers little improved insulation for the single story register box. Two story register boxes are typically about twice as tall to allow the connection of collars on the sides of the boxes. These boxes protrude completely out of the attic insulation and offer an ever greater source of energy loss.

[0005] Many energy losses can be reduced by eliminating unnecessary components and providing improved sealing methods. The widespread use of mastic on all mechanical joints has reduced air leaks but it is often used in unnecessary locations and in excessive amounts. Very little progress has been made on this front in recent years. There is a tendency in the industry to use cheaper foreign made parts that are inferior in quality and minimum wage contract labor to install such products. HVAC technicians are often relegated to starting and trouble shooting new installations. Due to the high volume of HVAC business, most decisions are based on costs rather than quality. There is fierce competition in the new home construction market and a real need to reduce all costs in order to remain in business. Larger HVAC contractors that install systems in national builder homes are resorting to the use of third party companies that gather all necessary components together and provide these as a complete installation kit. This process eliminates unnecessary materials, reduces time wasted while looking for forgotten parts and standardizes the products and methods used in each home. Standardization of parts and methods can lead to reduced energy losses if energy saving products are installed correctly.

[0006] Prior art has paid very little attention to the need for system components such as register boxes. There is a great tendency to keep replicating what has been done in the past. For example, recent improvements in the sealing and insulating of walls and ceilings as well as the use of more energy efficient windows have greatly reduced the need to position a ceiling register so that it will throw air toward such purported heat loads. The need for a register box has been derived from the need to provide an enclosure for the ceiling register and the associated opposed blade damper and to provide a collar for attaching a round air duct. The physical sizes of register boxes are typically determined by the size of the air duct that is used and the dimensions of the served room. A typical size that is referred to as for example, an 8 by 14, indicates that an 8 inch diameter duct is supplying air to a register box that is 14 inches long. This register box size would accommodate a medium size room while 4 by 10 might be used in a bathroom.

[0007] Rectangular or square ceiling registers attached to the ends of round air ducts cause rapid variations in airflow velocity and reduce the efficiency of air delivery throughout the structure. Opposed blade dampers offer further impediments to efficient airflow. All such discontinuities in the

airflow path create additional sources of noise in the affected rooms. Maintaining a constant airway diameter from the supply plenum to the ceiling register and providing an efficient valve seat to control the airflow rate offers significant improvements in airflow efficiency and noise reduction. Round valve seats work well with round air ducts to further reduce velocity variations and related noise sources. Where economics and architectural features make it necessary to use a variety of round air ducts, it is still very important to provide smooth transitions between diameters in order to provide efficient airflow. The attention to such details offers higher energy efficiency, reduced noise levels and improved comfort.

SUMMARY OF THE INVENTION

[0008] The present invention disclosed and claimed herein comprises a method and apparatus for eliminating register boxes, improving ceiling and wall penetration sealing, and reducing the labor and material costs to install ceiling registers. Basic system components are a collar plate assembly that interfaces with flexible or metal air ducts, at least one spring indentation ring in the collar portion of the collar plate assembly to accept two or more locking springs, at least two locking springs that attach to the ceiling register that is to be mounted in the ceiling or wall, mounting rails to attach the collar plate assembly to either ceiling or wall supports, and a trim ring that attaches between the collar and the ceiling or wall to eliminate air leakage and provide an essentially smooth flow of air from the supply duct into the inside environment of the structure. After ceiling or wall installation and surface preparation including hole cut-outs, texturing, and painting is completed, the ceiling register is simply positioned over the register cut-out and firmly inserted until it seals against the ceiling or wall surface and is simultaneously locked into place by the action of its locking springs expanding into the collar indentation ring. No mounting hardware is required and installation is both quick and easy. The preferred embodiment of the ceiling register is round, providing a 360 degree omnidirectional air flow pattern into the structure. Other ceiling register shapes, including square and rectangular, with differing outlet air flow patterns are within the scope of this patent and are included in these specifications. Such implementations do not in fact eliminate the need for a register box, but they do require that the register box be augmented with square or rectangular indentation rings which can also be only short indentation segments that match the corresponding locations of the locking springs. Ceiling registers include both automated (motorized) and manual controls for adjusting the volume of exiting air into the structure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description taken in conjunction with the accompanying Drawings in which:

[0010] FIG. **1** illustrates a cross-sectional view of the system of the present invention;

[0011] FIG. **2** illustrates a diagram of indentation ring shapes;

[0012] FIG. **3** illustrates a diagram of spring shapes;

[0013] FIG. **4** is a pictorial illustration of the major ceiling and wall penetration components; and

[0014] FIG. **5** illustrates alternate ceiling register configurations of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Referring to FIG. **1**, there is illustrated a cross-sectional view of a structure showing the system of the present invention, which comprises a method and apparatus for lowering the installed cost and improving the air flow performance of HVAC system ceiling registers **14**. Basic system components include an flexible air duct **1** that connects to the supply side of a conventional HVAC system. The open end of flexible air duct **1** then slides over inlet collar **2** of collar plate assembly **3**. Flexible air duct **1** is pulled past indentation ring **4** and anchored firmly at the plate portion **5** of collar plate assembly **3** using tie wrap **7** or other suitable fastener devices. This positions the flexible air duct **1** flush with the outer surface of the ceiling **6**, producing continuous insulation of the flexible air duct **1** down to the ceiling **6** interface. Rigid metal air duct is applied by slipping it over the crimped portion **8** of collar **2** and attaching it with metal fasteners such as sheet metal screws. The associated air duct insulation is attached in the same manner that flexible duct insulation is attached. In all cases, a suitable sealant such as mastik is applied to all joints to satisfy local building code requirements. Additional insulation protection around the ceiling register **14** is achieved when normal attic or wall insulation **21** is installed or blown in to achieve insulation R values which meet local building code requirements. This provides a second layer of insulation around and on top of the air duct insulation previously installed over the collar plate assembly **3**.

[0016] Collar plate assembly **3** is anchored to ceiling or wall supports by mounting rails **10** which slide over the edge of plate portion **5** and are attached to the supports at both ends by suitable fasteners such as screws or nails. Ceiling **6** is then installed and properly anchored to the ceiling or wall supports. Access holes **11** are cut through ceiling **6** at each collar plate assembly **3** using the inside surface of collar **2** as a guide for a smooth access hole **11** cut-out. Trim ring **12** is inserted through the access hole **11** and into the collar **2** of collar plate assembly **3** after suitable sealant is applied. This provides a smooth air tight connection from flexible air duct **1**, through collar plate assembly **3** into the room interior. Surface coating **13**, typically texturing and painting, is applied as required for appearance.

[0017] Ceiling register **14** is supplied with at least two locking springs **17** which are manufactured using a material exhibiting good spring characteristics. These locking springs **17** are attached to the ceiling register **14** in a manner such that they extend outward from the periphery of the ceiling register **14** and are compressed when the ceiling register **14** is inserted through access hole **11** and into the collar **2** of collar plate assembly **3**. Once surface coating **13** of ceiling **6** is complete, ceiling registers **14** are inserted through access hole **11** and into collar plate assembly **3** until locking springs **17** expand outwardly into indentation ring **4** and lock the ceiling register **14** into position. Indentation ring **4** is positioned during manufacture so that proper locking occurs when ceiling register **14** just makes contact with ceiling **6** interior surface. Locking spring **17** is constructed with sharp-pointed teeth to facilitate a tight grip as the contact point slides up into the indentation ring **4**. Indentation ring **4** is fabricated to allow the locking spring **17** teeth to lock in

over the range from the beginning of the indentation ring **4** to its maximum depth point. This allows proper locking of the ceiling register **14** with some variations in ceiling **6** and surface coating **13** thicknesses.

[0018] Ceiling register **14** contains an air valve that can be manually or electrically positioned (not illustrated) to allow any desired room air flow **20** up to the maximum available **19** from the attached flexible air duct **1**. The Air valve is similar to a water valve in function. It contains both a fixed seat **15** and movable seat **16** which is rotated and positioned by threaded assembly **18**. They prevent any airflow **20** when the movable seat **16** is positioned in the fully closed position or against the fixed seat **15**. The amount of airflow **20** that occurs when the air valve is open is directly proportional to the distance between the fixed seat **15** and the movable seat **16**. Manually controlled and electrically controlled (automated) air valves look identical once installed and can be mixed in a given installation to produce the desired air flow **20** into different zones of a structure.

[0019] Removal of ceiling register **14** from its locked position within collar plate assembly **3** is facilitated by use of a removal tool **22** which consists of a long rod with a handle and a right angle hook at the end of the rod. The ceiling register is removed by fully opening the valve and inserting removal tool **22** into the valve opening at a position opposite one of the locking springs **17**. The removal tool hook is positioned behind the locking spring **17** and sufficient force is applied to compress locking spring **17** enough so that its teeth lose contact with indentation ring **4**.

[0020] Referring to FIG. **2**, there is shown in detail three variations of the indentation ring **4** used with locking spring **17**. The left portion of FIG. **2** shows a semicircular indentation. It provides a suitable locking range for the ceiling register of approximately one half its diameter as indicated by the distance between beginning point **23** and apex point **24**. This is a commonly available indentation ring. The disadvantages of the semicircular indentation are that tt provides a limited locking range and all gripping force is lost if the locking spring **17** contact point is forced past the apex point **24**. The center indentation ring shown in FIG. **2** is a triangular indentation with linear slopes. It provides a suitable lock range for the ceiling register over the linear distance from point **25** to the apex at point **26**. Maximum suitable lock range is achieved in this design when the slope of the upper segment, beginning at point **26** is made parallel to the slope of compressed locking spring **17**. Advantages of the triangular shaped indentation ring are it provides a wider lock range and presents a constant slope at the locking spring **17** contact point over the whole lock range. The indentation ring shown on the right in FIG. **2** is a discrete stepped indentation. It provides small discrete steps in the lock range. The advantage of the discrete stepped indentation ring is it provides a much wider locking range between beginning point **27** and ending point **28**. The disadvantage is it potentially more difficult and costly to manufacture since it must be included in addition to conventional indentation ring **4** which is required as a stop for tie wrap **7**.

[0021] Referring to FIG. **3**, there is shown four variations of design for locking spring **17**. The upper set of locking springs designated **17**L and **17**R contain cut out slot **30** to allow mounting to ceiling register **14** by simply sandwiching each between the edge of the ceiling register board and the upper vertical post of fixed valve seat **15** as shown in FIG. **1**. Locking springs **17**L and **17**R are identical except that the upper portion is bent in opposite directions in the two views. This creates a right and left set of locking springs. Teeth **29** are identical and made very sharp to facilitate their biting into the contact points of indentation ring **4** when ceiling register **14** is properly mounted. When each locking spring **17** is mounted, teeth **29** are spaced an equal distance from the center line of ceiling register **14** to facilitate proper seating of ceiling register **14** into collar plate assembly **3**. The angle **33** between the straight vertical section and the upper bent section of locking spring **17** is critical and must be within the range of 45 degrees or less when the ceiling register **14** is properly inserted and installed into register collar **3**. This will maintain an adequate angle of attack at the contact points where teeth **29** on locking spring **17** make contact with indentation ring **4** for secure anchoring of the ceiling register **14**.

[0022] The locking spring design shown in the lower left of FIG. **3** contains two mounting holes **31** for direct attachment along the centerline of a conventional ceiling register using pop rivets, screws or other fasteners. The function of teeth **29** are the same as previously presented. Teeth **29** are spaced an equal distance apart to keep the ceiling register in the center of the collar. The angle of attack at the contact points where teeth **29** make contact with indentation ring **4** should again be 45 degrees or less for proper anchoring of the associated ceiling register.

[0023] The locking spring design shown in the lower right of FIG. **3** is another variation of the lower left design showing a single rounded end **32** rather than two sharp teeth. It is easier and less expensive to manufacture and can be used with appropriately designed indentation rings.

[0024] Referring to FIG. **4**, therein is shown a three dimensional pictorial view of the ceiling or wall penetration components that comprise the current invention. Rigid metal air duct **9** is shown as an alternative to flexible air duct **1**. The exploded view shows the mechanical relationships between the primary components. The Collar plate assembly **3** is captured between the mounting rails **10** which are used to attach the combination assembly to the ceiling or wall supports. The mounting rails **10** are typically 24 inches long to accommodate typical support spacings of 16 inches to 24 inches. The mounting rails **10** are completely flat on one surface to limit the gap between the plate **5** and the ceiling **6**. Installing the flat side of the mounting rail **10** against the ceiling or wall limits the gap to about one thickness of metal or about 0.025 inches. This eliminates the potential problem with air gaps on cool metal surfaces that can result in unwanted condensation. Even though cut out **11** is controlled by the inner surface of collar **2**, the actual resulting hole is often jagged and uneven. Trim ring **12** combined with a suitable sealant provides a rigid air-tight connection between the interior room and the rigid metal air duct **9**.

[0025] FIG. **5** shows some traditional ceiling register designs that have been augmented with two or more locking springs **17** to allow these registers to be used with the current invention. Round ceiling register **34** is typically made of metal and has been in use for many years. It typically contains three mounting holes that are used with screws to hold the register to a ceiling or wall. These holes have been eliminated since they are no longer needed. Round ceiling register **34** is simply inserted into collar **2** with indentation ring **4** properly positioned.

[0026] FIG. **5** also shows a conventional register box **36** that has been augmented with a short indentation segments

38 that match the corresponding locations of the locking springs 17 on rectangular register 35. Conventional register box flange 37 is provided as a ceiling or wall material cut-out guide where cutting is done on the outside surface of the conventional register box flange 37 so that the conventional register box flange 37 can protrude through the ceiling or wall material. Conventional register box 36 may also contain a rectangular indentation ring 4 instead of the short indentation segments 38. Round ceiling register 34 can also be inserted into a conventional square register box 36 that is augmented with an indentation ring 4 or short indentation segments 38. Rectangular register 35 is available in a variety of materials including steel, aluminum and plastic. These registers may be augmented with two or more locking springs 17 to allow them to be used in square or rectangular conventional register boxes 36 that are augmented with an indentation ring 4 or short indentation segments 38. Square registers may also be mounted using these methods.

What is claimed is:

1. A method for rapidly attaching ceiling registers, comprising the steps of:
- providing a collar plate assembly with an interior indentation ring that is positioned to accommodate specific ceiling and surface coating thicknesses;
- positioning and attaching said collar plate assembly between ceiling supports;
- connecting air duct to said collar plate assembly;
- positioning and connecting outer insulation of air duct to contact plate area of collar plate assembly;
- installing ceiling by attaching to ceiling supports;
- cutting an access hole in ceiling using the interior surface of collar plate as a guide;
- finishing interior surface of ceiling;
- and inserting ceiling register with integral locking springs into opening of collar plate assembly until said springs lock into said indentation ring.

2. The method of claim 1 wherein the indentation ring is semicircular in shape.

3. The method of claim 1 wherein the indentation ring shape is triangular in shape.

4. The method of claim 1 wherein discrete stepped indentation rings are used to accommodate a variety of ceiling and surface coating thicknesses.

5. The method of claim 1 wherein the width of the indentation is used to accommodate a wider variety of ceiling and surface coating thicknesses.

6. The method of claim 1 wherein the indentation ring is oriented in an opposite direction toward the center of the opening.

7. The method of claim 1 wherein the indentation ring serves a secondary role as a stop for the tie wrap used to attach the air duct to the collar plate.

8. The method of claim 1 wherein the collar plate assembly is captured using mounting rails that attach to the ceiling supports.

9. The method of claim 1 wherein the collar plate assembly is attached directly to the ceiling supports using fasteners.

10. The method of claim 1 wherein the plate portion of the collar plate assembly is removed and the collar is attached to the ceiling supports with mounting rails connected to the side of the collar.

11. The method of claim 1 wherein flexible air duct is used.

12. The method of claim 1 wherein rigid metal air duct is used by direct connection to the crimped portion of the collar plate assembly.

13. The method of claim 1 wherein the locking springs are made of spring steel.

14. The method of claim 1 wherein the locking springs are made of stainless steel.

15. The method of claim 1 wherein the locking springs are made of beryllium copper.

16. The method of claim 1 wherein the locking springs are made of plastic.

17. The method of claim 1 wherein the locking springs contain sharp points of contact with the indentation ring to improve locking resolution.

18. The method of claim 1 wherein more than two locking springs are used.

19. The method of claim 1 wherein a trim ring with sealing compound is installed between the collar and the inside surface of the ceiling to provide an airtight passage into the interior space.

20. A method for rapidly attaching ceiling registers, comprising the steps of:
- providing a conventional register box with an interior indentation ring that is positioned to accommodate specific ceiling and surface coating thicknesses;
- installing said conventional register box by attaching between ceiling supports;
- cutting an access hole in ceiling using the conventional register box flange of said conventional register box as a guide;
- finishing interior surface of ceiling;
- and inserting ceiling register with integral locking springs into opening of said conventional register box until said springs lock into said indentation ring.

21. The method of claim 20 wherein said interior indentation ring is replaced with short indentation segments.

23. A system for rapidly attaching ceiling registers, comprising:
- a collar plate assembly with an interior indentation ring that is positioned to accommodate specific ceiling and surface coating thicknesses;
- said collar plate assembly is mounted between ceiling supports;
- an air duct and outer insulation of air duct in connected to contact said collar plate assembly;
- the ceiling is installed by attaching to the ceiling supports;
- an access hole in ceiling is cut using the interior surface of collar plate as a guide;
- the interior surface of ceiling is finished;
- and a ceiling register with integral locking springs is inserted into opening of collar plate assembly until said springs lock into said indentation ring.

24. The system of claim 23 wherein the shape of the indentation ring is semicircular.

25. The system of claim 23 wherein shape of the indentation ring is triangular.

26. The system of claim 23 wherein multiple indentations rings are used to accommodate a variety of ceiling and surface coating thicknesses.

27. The system of claim 23 wherein the width of the indentation ring is used to accommodate a wider variety of ceiling and surface coating thicknesses.

28. The system of claim **23** wherein the indentation ring is oriented in an opposite direction toward the center of the opening.

29. The system of claim **23** wherein the indentation ring serves a secondary role as a stop for the tie wrap used to attach the air duct to the collar plate.

30. The system of claim **23** wherein the collar plate assembly is captured using mounting rails that attach to the ceiling supports.

31. The system of claim **23** wherein the collar plate assembly is attached directly to the ceiling supports using fasteners.

32. The system of claim **23** wherein the plate portion of the collar plate assembly is removed and the collar is attached to the ceiling supports with mounting rails attached to the side of the collar.

33. The system of claim **23** wherein flexible air duct is used.

34. The system of claim **23** wherein rigid metal air duct is used by direct connection to the crimped portion of the collar plate assembly.

35. The system of claim **23** wherein the locking springs are made of spring steel.

36. The system of claim **23** wherein the locking springs are made of stainless steel.

37. The system of claim **23** wherein the locking springs are made of beryllium copper.

38. The system of claim **23** wherein the locking springs are made of plastic.

39. The system of claim **23** wherein the locking springs contain sharp points of contact with the indentation ring to improve locking resolution.

40. The system of claim **23** wherein more than two locking springs are used.

41. The system of claim **23** wherein a trim ring with sealing compound is installed between the collar and the surface of the ceiling to provide an airtight passage into the interior space.

42. A system for rapidly attaching ceiling registers, comprising:

a conventional register box with an interior indentation ring that is positioned to accommodate specific ceiling and surface coating thicknesses;

said conventional register box is mounted between ceiling supports;

an access hole in ceiling is cut using the conventional register box flange as a guide;

the interior surface of ceiling is finished;

and a ceiling register with integral locking springs is inserted into opening of said conventional register box until said springs lock into said indentation ring.

43. The system of claim **42** wherein said indentation ring is replaced with short indentation segments.

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