United States Patent

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[72] Inventor **Theodore Joseph Morin, Jr.**
Needham, Mass.

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[73] Assignee **Industrial Magnetics, Inc.**
Canton, Mass.
a corporation of Massachusetts

[54] **MAGNETIC WELDING AND FORMING**
7 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **219/9.5,** 219/95
[51] **Int. Cl.** **B23k 13/00**
[50] **Field of Search** 219/7.5, 8.5, 9.5, 95, 151, 152, 153, 154, 97

[56] **References Cited**

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Primary Examiner—J. V. Truhe
Assistant Examiner—Hugh D. Jaeger
Attorney—William W. Rymer, Jr.

ABSTRACT: Apparatus for driving members toward each other with repulsive magnetic forces and including a magnetic driver, a magnetic coil and a connector secured to either the coil or driver and adapted to be secured to one of the members.

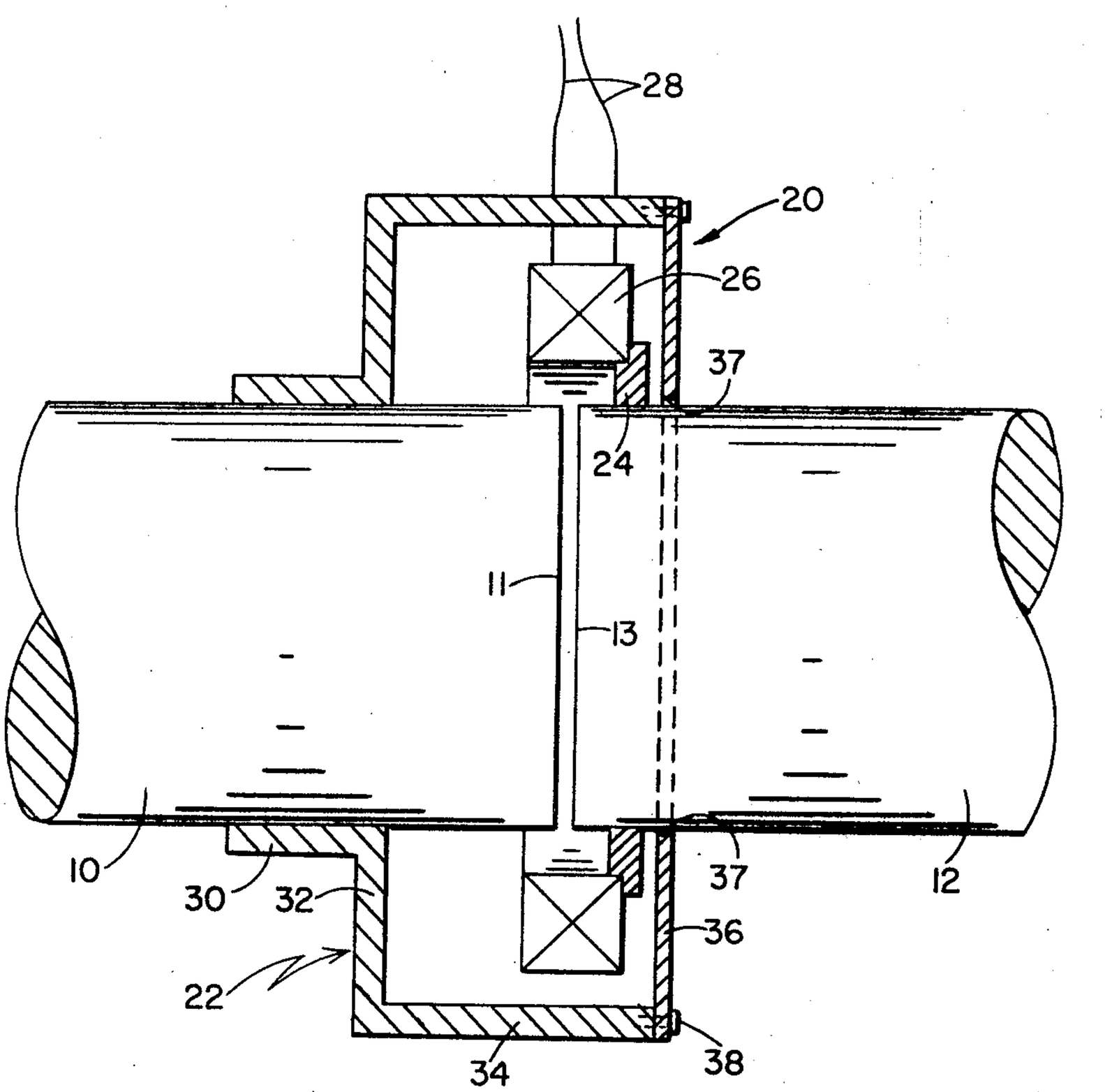

FIG. 1

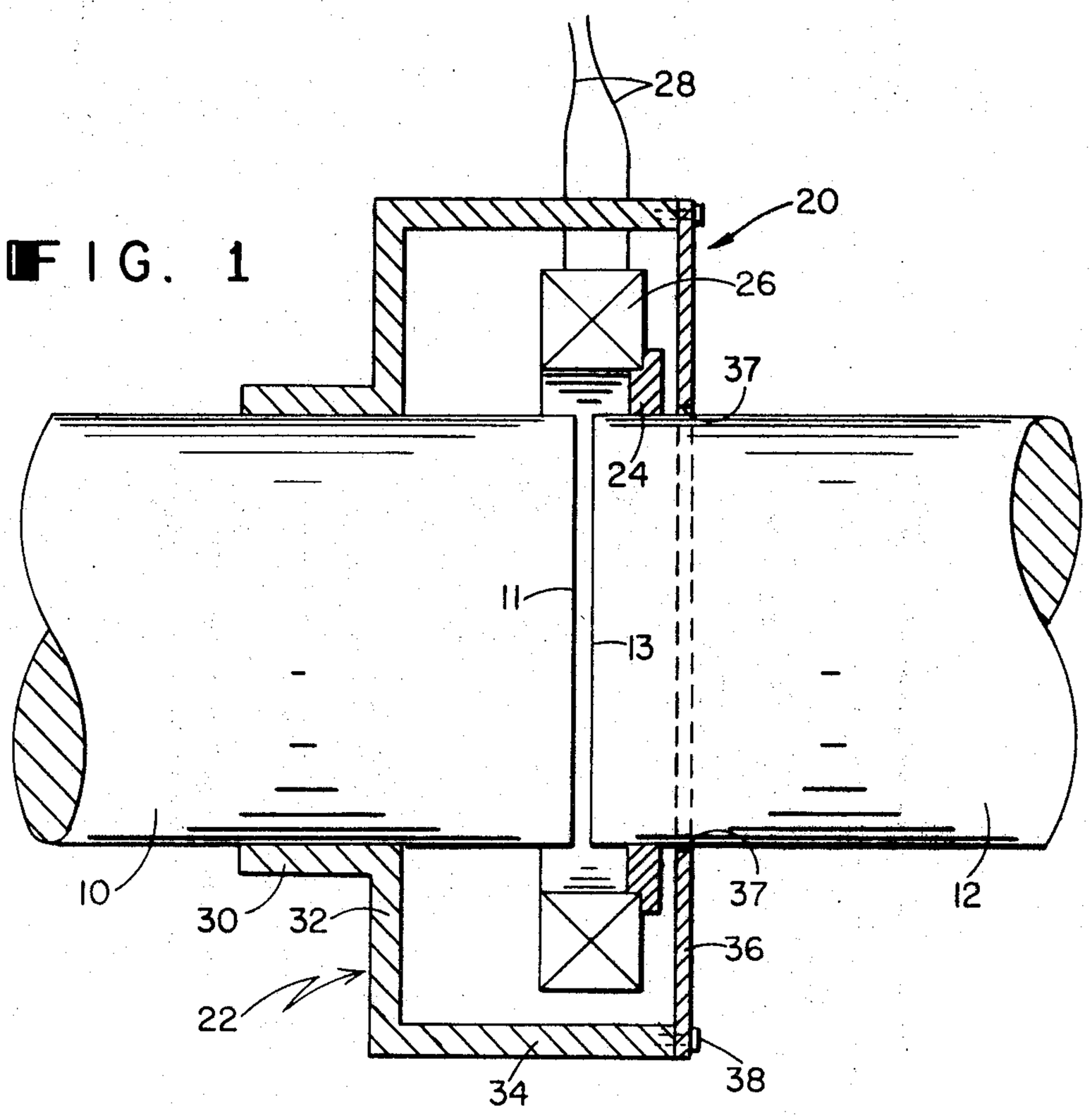
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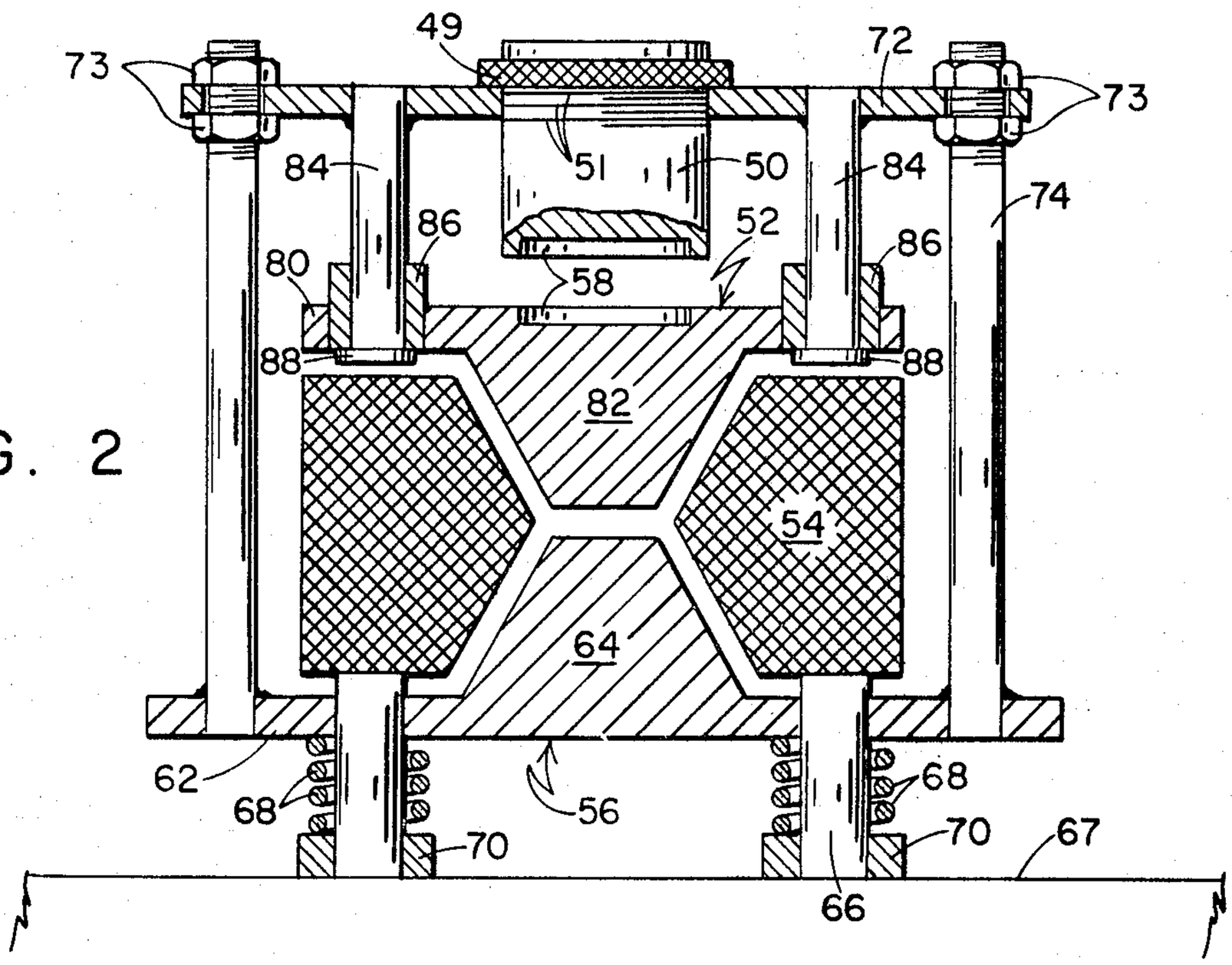
FIG. 2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MAGNETIC WELDING AND FORMING

This invention relates to magnetic welding, forming and forging.

It is a principal object of the invention to provide apparatus for drawing members together using repulsive magnetic forces. Other objects include providing novel and inexpensive buttwelding apparatus, forging apparatus or apparatus in which no outside forces need be applied and in which the work area may be easily enclosed.

The invention features a magnetic coil, a magnetic driver mounted on one side of the coil for repulsive interaction with the coil, and a first connector secured to either the coil or driver and adapted for securing to one of the members. In preferred embodiments there are featured buttwelding apparatus in which the driver and connector define an annular chamber substantially enclosing the work area, and forging apparatus including a second driver mounted on the other side of the coil.

Other objects, features and advantages will appear from the following description of preferred embodiments of the invention, taken together with the attached drawings thereof, in which:

FIG. **1** is a sectional view of a buttwelding apparatus embodying the invention; and

FIG. **2** is a sectional view of a forging apparatus embodying the invention.

Referring now to FIG. **1**, there is illustrated magnetic welding apparatus **20** including a connecting cylinder **22**, a magnetic driver or driving plate **36**, and a magnetic and induction heating coil **26**, for buttwelding the adjacent axially facing ends **11**, **13** of two metal pipes **10**, **12** together. Coil **26** is mounted, and centered by, a coil clamp **24** press fitted near the end **13** of pipe **12**. Input leads **28** connect the coil to an electrical energy source (not shown) of a type illustrated in the copending application of Peter Dominic Prevett and Theodore Joseph Morin, entitled "Conductive Solids Welding Circuitry," Ser. No. 717,804,like the present application, assigned to Industrial Magnetics, Inc.

Connecting cylinder **22** comprises an annular pipe clamp **30** press fitted to pipe **10**, a cylindrical wall **34** surrounding the work area defined by ends **11**, **13** of pipes **10**, **12** and extending past coil **26**, and a radially extending annular intermediate wall **32** connecting clamp **30** and cylindrical wall **34**.

Magnetic driver **36** is attached to the open end of cylindrical wall **34** with fasteners **38** in position closely adjacent but electrically spaced from coil **26**. Pipe **12** extends perpendicularly through a central hole **37** in driver **36**. The diameter of hole **37** is slightly greater than the outside diameter of pipe **12** to avoid binding.

As illustrated, connecting cylinder or connector **22** and driver **36**, in conjunction with pipes **10**, **12**, define an almost closed (except for the small annulus between driver **36** and pipe **12**) chamber surrounding the work area.

In operation, a high frequency current is passed through coil **26** to create a changing magnetic field to inductively heat the adjacent ends of pipes **10**, **12**. When the pipe ends have been heated to the desired temperature a large transient current pulse is introduced into coil **26**. The current pulse in the coil creates a pulsing magnetic field which induces a current in nearby driving plate **36** and a concomitant magnetic field. The two fields repel each other, driving plate **36** away from coil **26** and, thereby, forcing the ends of pipes **10** and **12** together, forming the weld.

FIG. **2** shows a forge apparatus including a hammer **50**, an anvil **52**, a coil **54**, and a main driver **56**. The hammer and anvil have opposing die mounts **58**.

Coil **54**, which provides the pulsed magnetic field in a manner similar to that of the coil of the previous embodiment, has the cross section shown in FIG. **2**, bulging slightly inwardly at the center.

Driver **56** includes an outside platelike flange **62** extending beneath the coil and beyond its outside dimension, and a central frustroconical portion **64** extending up into the center of the coil.

Coil **54** is securely mounted on cylindrical supports **66** extending upwardly from a base **67** through holes in flange **62** of driver **56**. The driver is supported on springs **68** mounted on spring supports **70**, both surrounding supports **66**.

The upper portion **51** of hammer **50** is threaded for adjustably supporting the hammer in a threaded central hole in hammer support plate **72**. A lock ring **49** is provided to prevent rotation of the hammer relative to support plate **72**.

Support plate **72** is mounted, by nuts **73**, on vertical connecting rods **74** which are welded at their lower ends to flange **62** of driver **56**.

Anvil **52** has a shape similar to driver **56**, including an outer flange portion **80** and frustroconical inner portion **82** extending into the center of coil **54**. The outside diameter of portion **80** is approximately equal to that of coil **54**. Anvil **52** is supported by guide rods **84** extending from plate **72**, to which they are welded through guide bushings **80** in the flange **80** of anvil **52**. A stop or head **88** is provided at the lower end of each guide rod **84**.

In operation coil **54** is energized by a current pulse as in the previous embodiment. The repulsive forces generated cause driver **56** to move down away from the coil. Hammer **50** follows the motion of the driver because it is connected to it by connecting rods **74** and plate **72**. Anvil **52**, which acts as a secondary driver, is moved away from the coil in an upward direction along guide rods **84** by the forces generated when the coil is pulsed.

Hammer and anvil are thus driven together and with appropriate dies in die mounts **58** a workpiece placed between them can be formed.

Other embodiments will occur to those skilled in the art and are within the following claims.

I claim:

1. Apparatus for buttwelding the adjacent, generally axially facing surfaces of a pair of longitudinally extending members together using repulsive magnetic forces, said apparatus comprising:

a magnetic coil generally surrounding said surfaces;

a magnetic driver for repulsive interaction with said coil; and,

a connector secured to one of said coil and said driver and including a connector portion adapted to be secured to one of said members,

the other of said driver and said coil being intermediate said one and said connector portion whereby movement of said driver and said coil away from each other in response to said repulsive interaction draws said surfaces together.

2. The apparatus of claim **1** including a second connector secured to the other of said coil and said driver and having a second connector portion adapted to be secured to the other of said members.

3. The apparatus of claim **1** in which said connector includes a generally cylindrical wall portion surrounding said axially facing faces of said members.

4. The apparatus of claim **3** in which said connector is secured to said driver.

5. The apparatus of claim **4** in which said driver is generally planar and defines an opening through which one of said members extends in a direction generally perpendicular to said driver, and said connector is secured to the other of said members.

6. The apparatus of claim **4** wherein said connector and said driver provide an annular chamber adapted for enclosing the portions of said members defining said axially facing surfaces.

7. The apparatus of claim **6** wherein said coil is mounted within said chamber.