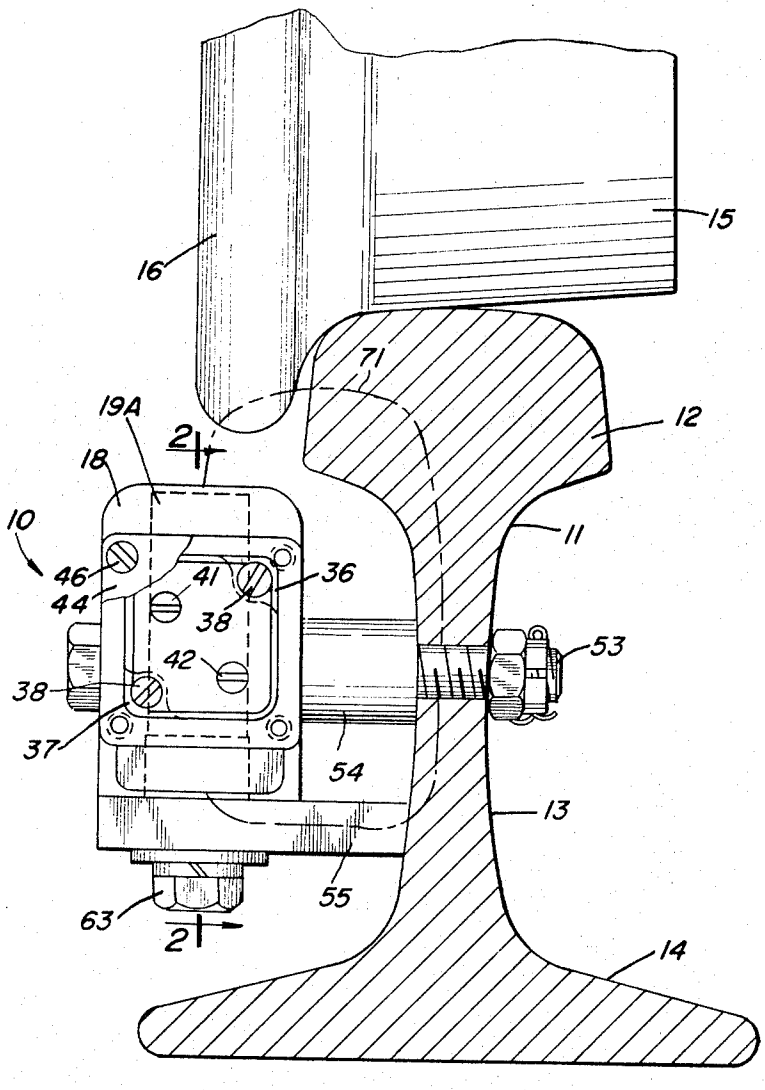
July 9, 1968 A. R. CRAWFORD 3,392,279

MAGNETIC TRANSDUCER RAILROAD WHEEL DETECTOR

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Fig. 1




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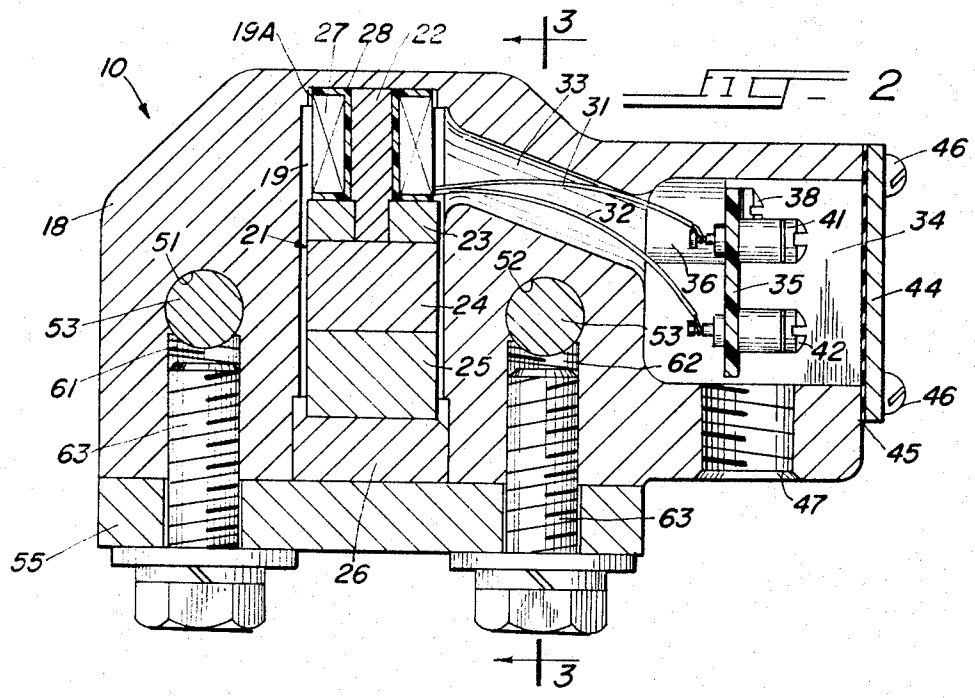



Fig. 2

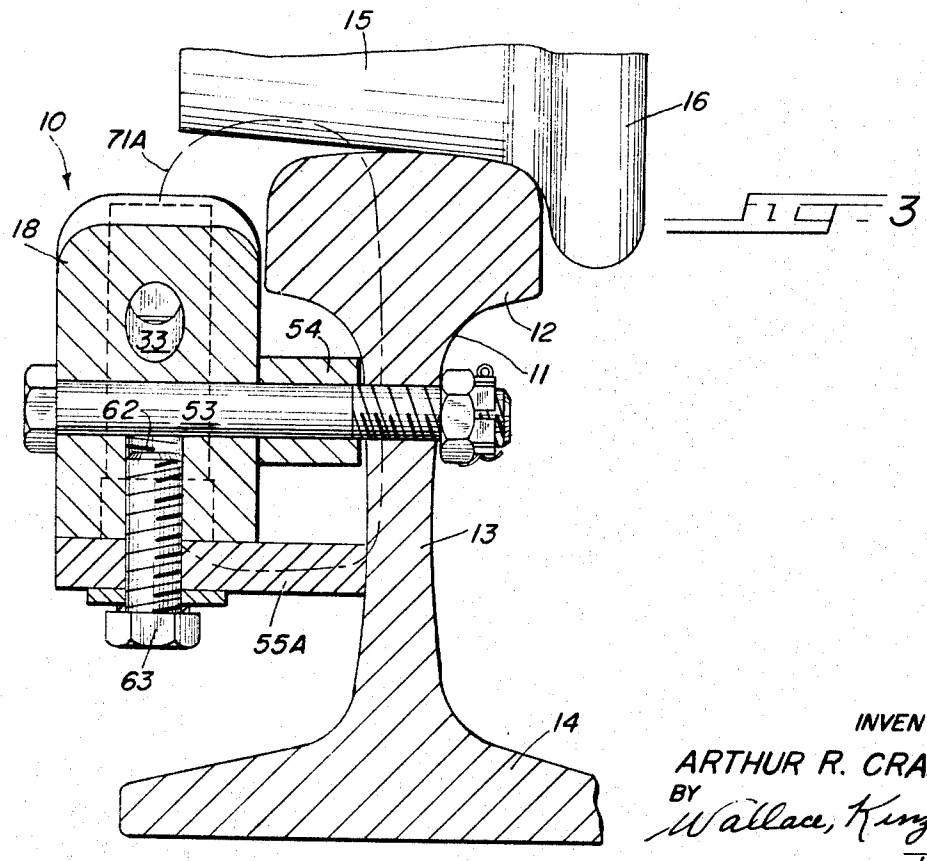



Fig. 3

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3,392,279

# MAGNETIC TRANSDUCER RAILROAD WHEEL DETECTOR

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5 Claims. (Cl. 246—249)

## ABSTRACT OF THE DISCLOSURE

A rugged all metal magnetic transducer for use as a railroad wheel detector. The transducer comprises a one-piece solid cast aluminum housing having a dead-ended vertical cavity in which a magnetic core is mounted with an electrical coil encompassing a part of the core. The core is tightly held in the cavity by a magnetic plug member. The transducer is mounted on a rail with the closed end of the cavity in one of two predetermined positions adjacent the rail head, the first position being immediately adjacent the lower surface of the rail head for flange-side mounting and the second position being just below the top surface of the rail head for wheel-side mounting. The mounting means includes a pair of bolts with spacer members for securing the housing to the web of the rail and a removable magnetic pole piece extending from the plug member into engagement with the rail web. The dimensions of the spacer members and the pole pieces are matched to the rail dimensions to permit secure mounting of the transducer at either of the first and second positions with the pole piece in firm flux-transmitting contact with the rail web.

This invention relates to a new and improved magnetic transducer and particularly to a magnetic transducer effective to detect movement of a railway wheel past a given point on a conventional steel rail of the kind comprising a relatively wide head supported upon a narrow vertically extending web.

In the control of railway classification yards, and in other applications entailing the control of railway operations, it is frequently necessary to detect the movement of railway cars or locomotives past a given point on the railway. This is frequently accomplished by means of track switches, mounted on the rail and positioned to be engaged by the flange of a wheel passing along the rail. Track switches employed for this purpose are subjected to a quite adverse environment; thus, these switches must be capable of withstanding substantial vibration, relatively heavy shock loading, and heavy impact loading, from the railway vehicles wheels by which they are engaged and from the rails on which they are mounted. The working environment for switches of this kind is almost invariably a very dirty one. Moreover, the switches may be subject to substantial stresses when repair work is carried forward on adjacent sections of the rail. As a consequence, and despite substantial precautions in construction of devices of this kind, it is sometimes quite difficult to maintain conventional track switches in operation.

One kind of device known in the prior art which offers a solution to some of the problems encountered with conventional track switches constitutes a magnetic proximity detector or transducer. One such device, as shown in Hess Patent No. 3,187,127, comprises a magnetically actuated reed switch mounted adjacent a permanent magnet structure, the flux circuit for the permanent magnet being momentarily closed, to a substantial extent, by the movement of a railway wheel flange past the permanent magnet. A device of this kind avoids some of the disadvantages due to impact and shock loading upon engagement of the railway wheel with a conventional track switch. On the other hand, the delicate reed switch may present some problems with respect to maintenance of effective discriminatory action in the presence of substantial vibration of the rail.



Another device of this general kind, which is not a true switch but constitutes a magnetic tranducer having no moving parts, is shown in Pelino Patent No. 2,973,430. The Pelino device comprises a permanent magnet and appropriate pole pieces mounted within a plastic housing, with an electrical coil encompassing the permanent magnet or one of the pole pieces. The magnetic circuit is arranged so that the flange of a wheel passing the device moves through an air gap in the magnetic circuit, inducing an electrical pulse in the coil that can be detected and employed for control purposes. A somewhat similar but considerably more complex device, using alternating current, is disclosed in Hofstetter et al. Patent No. 3,015,725. Magnetic transducers of this particular kind do not require physical engagement between the transducer and the railway wheel and do not entail physical movement of switch elements, minimizing the adverse effects of impact and shock loading of the device.

However, damage may occur due to heavy vibration loading and to the dirty environment in which the device is required to operate. Moreover, devices of this kind, as previously known, have all required mounting of the transducer on the outer side of the rail, referred to as the flange side of the rail, because effective operation is predicated upon movement of the wheel flange through a magnetic field created by the device. In many applications, this mounting arrangement presents no great disadvantage; however, in those instances in which it is necessary to position the detector on the inside or wheel side of the rail, substantial problems may be encountered.

It is a primary object of the present invention, therefore, to provide a new and improved magnetic transducer for detecting movement of a railway wheel past a given point on a conventional steel rail that inherently and effectively eliminates the problems and difficulties encountered with previously known devices as set forth above.

A specific object of the invention is to provide a new and improved magnetic transducer that can be used in place of conventional track switches, in railway operations, and that is rugged, durable, and virtually immune to damage or failure resulting from vibration, shock, impact loading or dirt.

Another important object of the invention is to provide a new and improved magnetic transducer for detecting movement of a railway wheel past a given point on a conventional steel rail and that may be mounted on either side of the rail.

A specific object of the invention is to provide a new and improved magnetic proximity detector for detecting movement of a railway wheel past a given point on a railway that is rugged and durable and can be mounted on either the flange side or the wheel side of the rail, yet which is simple and economical in construction and provides for mounting on the rail with a minimum of labor and material.

Accordingly, the present invention is directed to a magnetic transducer for detecting movement of a railway wheel past a given point on a rail of the kind comprising a relatively wide head supported upon a narrow web. A magnetic transducer constructed in accordance with the invention, comprises a one-piece solid non-ferrous metal housing, preferably aluminum, having a dead ended coil-receiving cavity extending thereinto. A magnetic core extends axially of the coil-receiving cavity; this core includes a magnetic plug member that closes the open end of the cavity that preferably is press fit into the housing. At least one electrical coil is mounted within the cavity

in encompassing relation to a portion of the magnetic core. One coil is sufficient for a DC transducer but two coils are usually required if an AC system is utilized. Mounting means are provided for mounting the transducer housing on the web of a rail with the coil-receiving cavity extending in a vertical direction approximately parallel to the web of the rail and with the closed dead end of the cavity in predetermined position adjacent the head of the rail. In the preferred construction described hereinafter, the mounting means provides for mounting the transducer in either one of two positions, the first position locating the closed dead end of the cavity immediately adjacent the lower surface of the rail head for flange-side mounting of the transducer, and the second position locating the closed dead end of the cavity only slightly below the top surface of the rail head or wheel-side mounting. The mounting means includes a magnetic pole piece that is detachably affixed to the housing in engagement with the magnetic plug member that closes the coil-receiving cavity; this pole piece extends laterally of the housing into firm engagement with the web of the rail.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, show a preferred embodiment of the present invention and the principles thereof and what is now considered to be the best mode contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be made as desired by those skilled in the art without departing from the present invention and the purview of the appended claims.

In the drawings:

FIG. 1 is an end elevation view of a magnetic transducer constructed in accordance with one embodiment of the invention, showing the transducer mounted on a railway rail with a wheel passing the transducer;

FIG. 2 is a sectional elevation view taken approximately along line 2—2 in FIG. 1; and

FIG. 3 is a sectional view of the transducer taken approximately along line 3—3 in FIG. 2 and illustrates the mounting arrangement of the transducer employed for wheel-side mounting of the rail.

FIG. 1 illustrates a magnetic transducer device **10**, constructed in accordance with the present invention, mounted upon a conventional steel railway rail **11**. Rail **11** is of conventional construction and comprises a relatively wide, thick head **12** supported upon a narrow vertically extending web **13** which extends upwardly from the usual base flange **14**. Transducer **10** is positioned to detect movement of a railway wheel such as the wheel **15** past the point on rail **11** where the transducer is mounted. In FIG. 1, transducer **10** is mounted on the side of rail **11** constituting the outside of the railway along which the flange **16** of wheel **15** moves. Thus, FIG. 1 illustrates flange-side mounting for the transducer; wheel-side mounting is illustrated in FIG. 3 and is discussed hereinafter.

The magnetic transducer **10** comprises a one-piece solid non-ferrous metal housing **18**. As best illustrated in FIG. 2, housing **18** is provided with a vertically extending dead-ended coil-receiving cavity **19**. A magnetic core structure **21** is mounted within cavity **19** and extends axially of the cavity from end to end thereof.

The magnetic core structure **21** mounted within cavity **19** comprises an internal pole piece **22** that extends downwardly from the upper or dead end of cavity **19**. The internal pole piece **22** is press fit or otherwise suitably secured in a washer **23** that supports the pole piece upon the upper surface of a first permanent magnet **24**. Magnet **24**, in turn, is supported upon a second permanent magnet **25**. The lower or open end of cavity **19** is closed by a magnetic plug member **26**. Plug **26** may be fabricated from soft steel or any other suitable low-reluctance magnetic material. The lower surface of the plug is preferably disposed flush with the lower surface of housing **18**. In any event, the plug should not be spaced inwardly of the lower surface of the housing to any substantial extent to avoid introducing an unnecessary air gap into the magnetic circuit of transducer **10**.

An electrical coil **27** is mounted on the internal pole piece **22** that comprises a part of magnetic core structure **21**. Coil **27** may be wound upon an appropriate bobbin or coil form **28** and is disposed in encompassing relation to pole piece **22**. A single electrical coil **27** having but two external leads **31** and **32**, as illustrated in FIG. 2, may be utilized where transducer **10** is intended for DC operation. On the other hand, if an AC system is required, then two windings are usually employed instead of the single coil **27**; where two windings are utilized, the may be bifilar, concentric, or axially separated coils.

Appropriate means are provided for making electrical connections to the two leads **31** and **32** of coil **27**. In the specific arrangement illustrated in FIG. 2, the electrical leads extend through a small passage **33** from cavity **19** into a terminal board cavity **34**. A terminal board **35** is mounted within cavity **34**, upon a pair of bosses **36** and **37** formed within cavity **34** and constituting integral parts of the housing casting **18**. Suitable screws **38** are employed to mount terminal board **35** upon bosses **36** and **37**. Terminal board **35** carries two conventional terminals **41** and **42** to which leads **31** and **32** respectively, are connected.

The right-hand end of cavity **34**, as seen in FIG. 2, is closed and sealed by an appropriate cover plate **44** and gasket **45** secured to housing **18** by appropriate screws or other mounting devices **46**. Electrical connections to terminals **41** and **42** may be effected by apropriate electrical leads brought through an opening **47** tapped to receive an apropriate closure plug. The construction of the electrical leads and the closure plugs are not critical with respect to the present invention and are not illustrated in the drawings. Indeed, the complete terminal arrangement illustrated in FIG. 2 can be omitted from transducer **10** and replaced by a simple fixed plug connection in the side wall of housing **18**, omitting the projecting portion of the housing containing cavity **34** entirely. The illustrated construction utilizing the terminal board is sometimes preferred for convenience of making electrical connections in the field.

Means are provided for mounting housing **18** on the web **13** of rail **11** with cavity **19** extending in a generally vertical direction and approximately parallel to the web of the rail. The position of the device for flange-side mounting on rail **11** is illustrated in FIG. 1, the closed dead-end **19A** of cavity **19** being located just below the lower surface of the head **12** of the rail.

The mounting means for device **10** comprises a pair of mounting bolts **53** which extend through apertures **51** and **52** in the cast metal housing **18**. Preferably, there is no physical connection between cavity **19** and apertures **51** and **52**. Moreover, the apertures for the mounting bolts may be spaced by a reasonable distance from the magnetic core structure within cavity **19** to avoid substantial magnetic coupling between the mounting bolts **53** and the magnetic core of the transducer. As shown in FIG. 1, each of the mounting bolts **53** extends through an appropriate aperture drilled in the web **13** of rail **11**. Moreover, an appropriate spacer **54** is mounted in encompassing relation to each of the bolts **53** to position housing **18** with its upper surface immediately below the head of the rail and displaced outwardly of the head so as to be immediately below the flange **16** of a wheel passing the transducer.

The mounting means for transducer **10** further include a magnetic pole piece **55** that is detachably mounted upon the bottom of housing **18**. Thus, within housing **18** there are two vertically extending tapped holes **61** and **62**. The tapped holes **61** and **62** preferably form T-connections with the horizontal openings **51** and **52**, this being the

most economical arrangement from the standpoint of fabricating casting **18**. A pair of mounting screws **63** extends through appropriate apertures in the external pole piece **55** and are threaded into the tapped openings **61** and **62** to detachably mount the external pole piece on the bottom of housing **18**. Pole piece **55** should contact the closure plug **26** that forms the bottom-most member of the magnetic core structure within cavity **19** in order to avoid introduction of an unwanted air gap in the magnetic structure of the transducer. Appropriate lock washers and spacer washers may be utilized in connection with the screws **63** as desired.

With transducer **20** mounted in flange-side position on rail **11**, as illustrated in FIG. 1, the magnetic flux produced within core structure **21** by the permanent magnets **24** and **25** that comprise a part of that core structure (FIG. 2) traverses a flux path indicated generally by the phantom line **71** in FIG. 1. This flux path, beginning at the uppermost or dead-end **19A** of the coil cavity within the transducer, and hence at the upper end of pole piece **22** (see FIG. 2), extends across a substantial air gap to the head **12** of rail **11**. From the head of the rail, the flux path extends down through the web **13** of the rail and into the magnetic external pole piece **55** of the transducer. Pole piece **55** should be in firm contact with the web of the rail to avoid introduction of an air gap into the magnetic circuit between these members. The flux path is returned to the internal core structure through the engagement of external pole piece **55** with the low reluctance plug **56** that forms the bottom-most member of the core structure **21**.

Ordinarily, the reluctance of the magnetic circuit generally illustrated by the phantom line **71** in FIG. 1 is quite high. The high reluctance results from the presence of the large air gap between the rail head **12** and the transducer. When a car wheel **15** passes the transducer, however, the wheel flange **16** passes through this air gap and materially reduces its length. As a consequence, the total flow of flux is momentarily increased with the result that an electrical signal pulse is induced in the coil **27** in transducer **10**. This signal pulse, representing movement of a rail wheel past the transducer, can be utilized to actuate a relay or other suitable switching device at a remote switching station to effect any desired control action. The bolts **53**, although usually of magnetic material, do not enter into the magnetic circuit because they are each spaced by a substantial high reluctance gap from the magnetic core structure within the transducer and hence carry only a negligible part of the total flux for the magnetic circuit.

Transducer **10**, as described hereinabove, is rugged, durable, and virtually immune to damage from vibration and shock in the course of use. The solid one-piece casting constituting housing **18** protects the coil **27** from damage from virtually any source. There are no loose or moving parts, complete core structure **21** being held firmly in place within the housing by the press fit plug **26** that is a part of the core structure. The mounting means utilized to mount the transducer on the web of the rail is completely separate from the coil structure. The electrical connections to the coil can be completely sealed, so that dirt in the environment in which the transducer is used presents little or no problem. The housing itself is inherently stronger than a fabricated sheet metal or plastic housing. On the other hand, the number of machined parts is held to a minimum and the overall expense of the transducer is quite low.

The detachable mounting employed for the external pole piece **55** makes it possible to use external pole pieces of slightly different dimensions. This feature of the present construction makes it possible to compensate for variations in the dimensions of rail **11** without requiring any change in the main structure of the transducer itself. Furthermore, the use of the detachable external pole piece and the separate spacers **54**, or either of them, permits mounting of the transducer on the wheel side of a rail as well as on the flange side. That is, by varying the projection length of the external pole piece **55** or the length of the spacers **54**, or both of them, transducer **10** can be mounted on the rail for wheel-side operation instead of flange-side operation, the wheel-side mounting arrangement being illustrated in FIG. 3.

In the wheel-side mounting arrangement illustrated in FIG. 3, the spacers **54** remain unchanged in length. The hole through rail web **13** for the mounting bolt **53** is drilled at a high location. The only other change required, in this instance, is the provision of an external pole piece **55A** that is slightly longer than the initially described pole piece **55**, the additional length being required because pole piece **55A** now contacts web **13** at a point where the web is somewhat narrower than in the case of the flange side mounting illustrated in FIG. 1.

With the arrangement shown in FIG. 3, the flux path for the transducer is now generally illustrated by phantom line **71A**. The magnetic flux does not turn an abrupt corner, but rather arches through a substantial air gap before reaching rail head **12**, the air gap being somewhat longer than with flange-side mounting. The tread of the wheel **15**, however, fills much of this air gap when the wheel passes the transducer. Consequently, a usable electrical pulse is developed when the wheel passes the transducer, just as in the case of the flange-side mounting described above.

It is essential, however, for wheel-side mounting, that the upper surface of the transducer be located near the level of the upper surface of the head **12** of the rail. If this is not done, then the flux path may proceed primarily to the side of the head of the rail and the passing wheel will not enter sufficiently into the air gap to produce a usable electrical pulse. The transducer should always be maintained somewhat below the top of the head of the rail in order to avoid damage to the transducer from a so-called "double flanged" wheel, a worn wheel which projects somewhat down below the top of the head of the rail on the side opposite the wheel flange.

From the foregoing description, and from FIG. 3, particularly when compared with FIG. 1, it is clear that the transducer of the present invention is adaptable to both wheelside and flange-side mounting and is not limited to a flange-side arrangement as has been the case with most prior art devices. Moreover, this versatility is readily accomplished through selection of an appropriate size of external pole piece and does not add materially to the cost of the transducer. Indeed, the main body of the transducer remains unchanged for mounting on either side of the rail.

Hence, while preferred embodiments of the invention have been described and illustrated, it is to be understood that they are capable of variation and modification, and I therefore do not wish to be limited to the precise details set forth, but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

**1.** A magnetic transducer, for detecting movement of a railway wheel past a given point on a rail of the kind comprising a relatively wide head supported upon a narrow web, comprising:

a one-piece solid cast aluminum housing having a dead-ended coil-receiving cavity extending thereinto;

a magnetic core extending axially of said cavity and including an internal pole piece and at least one permanent magnet;

a magnetic plug member press fit into the open end of said cavity to close said open end and constituting a part of said magnetic core;

an electrical coil mounted within said cavity in encompassing relation to said internal pole piece;

and mounting means for mounting said housing on the web of a rail with said cavity extending in a

vertical direction approximately parallel to the web of the rail and with the closed dead end of said cavity in predetermined position adjacent the head of the rail at either one of two locations with said dead end of said cavity approximately aligned with the lower edge of the rail head for one of said locations and with the dead end of said cavity disposed only slightly below the top of the rail head for the other location;

said mounting means including a magnetic pole piece affixed to said housing in engagement with said plug member and extending laterally of said housing into engagement with the web of the rail.

2. A magnetic transducer, for detecting movement of a railway wheel past a given point on a rail of the kind comprising a relatively wide head supported upon a narrow web, comprising:

a one-piece solid aluminum housing having a dead-ended coil-receiving cavity extending thereinto;

a magnetic core extending axially of said cavity and including a magnetic plug member closing the open end of said cavity;

at least one electrical coil mounted within said cavity in encompassing relation to a portion of said core;

and mounting means for mounting said housing on the web of a rail with said cavity extending in a vertical direction approximately parallel to the web of the rail and with the closed dead end of said cavity in predetermined position adjacent the head of the rail at either one of two locations with said dead end of said cavity approximately aligned with the lower edge of the rail head for one of said locations and with the dead end of said cavity disposed only slightly below the top of the rail head for the other location;

said mounting means including a pair of elongated mounting bolts extending horizontally through individual apertures in said housing, separate from said cavity, and through the rail web, and a pair of spacer members on said bolts intermediate said rail web and said housing;

said mounting means further including a magnetic pole piece detachably affixed to the bottom of said housing in engagement with said plug member and extending laterally of said housing into engagement with the web of the rail.

3. A magnetic transducer, for detecting movement of a railway wheel past a given point on a rail of the kind comprising a relatively wide head supported upon a narrow web, comprising:

a one-piece solid non-ferrous metal housing having a dead-ended coil-receiving cavity extending thereinto;

a magnetic core extending axially of said cavity and including a magnetic plug member closing the open end of said cavity;

at least one electrical coil mounted within said cavity in encompassing relation to a portion of said core;

and mounting means for mounting said housing on the web of a rail with said cavity extending in a vertical direction approximately parallel to the web of the rail and with the closed dead end of said cavity at one of two predetermined positions adjacent the head of the rail;

the first of said positions being immediately adjacent the lower surface of the rail head for flange-side mounting of the transducer and the second of said positions being only slightly below the top surface of the rail head for wheel-side mounting;

said mounting means including a magnetic pole piece detachably affixed to the bottom of said housing in engagement with said plug member and extending laterally of said housing into engagement with the web of the rail.

4. A magnetic transducer, for detecting movement of a railway wheel past a given point on a rail of the kind comprising a relatively wide head supported upon a narrow web, comprising:

a one-piece solid aluminum housing having a dead-ended coil-receiving cavity extending thereinto;

a magnetic core extending axially of said cavity and including a magnetic plug member closing the open end of said cavity;

at least one electrical coil mounted within said cavity in encompassing relation to a portion of said core;

and mounting means for mounting said housing on the web of a rail with said cavity extending in a vertical direction approximately parallel to the web of the rail and with the closed dead end of said cavity at any one of two predetermined positions adjacent the head of the rail;

the first of said positions being immediately adjacent the lower surface of the rail head for flange-side mounting of the transducer and the second of said positions being only slightly below the top surface of the rail head for wheel-side mounting;

said mounting means including a pair of elongated mounting bolts extending horizontally through individual apertures in said housing, separate from said cavity, and through the rail web, and a pair of spacer members on said bolts intermediate said rail web and said housing;

said mounting means further including an external magnetic pole piece detachably affixed to the bottom of said housing in engagement with said plug member and extending laterally of said housing into engagement with the web of the rail;

the dimensions of said spacer members and said external pole piece being matched to the dimensions of the rail to permit stable mounting of said transducer at either of said first and second positions with said external pole piece in firm flux-transmitting contact with the web of the rail.

5. A magnetic transducer, for detecting movement of a railway wheel past a given point on a rail of the kind comprising a relatively wide head supported upon a narrow web, comprising:

a one-piece solid cast aluminum housing having a dead-ended coil-receiving cavity extending thereinto;

a magnetic core extending axially of said cavity and including an internal pole piece and at least one permanent magnet;

a magnetic plug member closing the open end of said cavity and constituting a part of said magnetic core;

an electrical coil mounted within said cavity in encompassing relation to said internal pole piece;

and mounting means for mounting said housing on the web of a rail with said cavity extending in a vertical direction approximately parallel to the web of the rail and with the closed dead end of said cavity in one of two predetermined positions adjacent the head of the rail;

the first of said positions being immediately adjacent the lower surface of the rail head for flange-side mounting of the transducer and the second of said positions being only slightly below the top surface of the rail head for wheel-side mounting;

said mounting means including a pair of elongated mounting bolts extending horizontally through individual apertures in said housing, separate from said cavity, and through the rail web, and a pair of spacer members on said bolts intermediate said rail web and said housing;

said mounting means further including a magnetic pole piece detachably affixed to the bottom of said housing in engagement with said plug member and extending laterally of said housing into engagement with the web of the rail;

the dimensions of said spacer members and said external pole piece being matched to the dimensions

of the rail to permit stable mounting of said transducer at either of said first and second positions with said external pole piece in firm flux-transmitting contact with the web of the rail.

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