

Selection of Centralizers for Primary Cementing Operations

API TECHNICAL REPORT 10TR4
FIRST EDITION, MAY 2008



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Upstream Department

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Contents

	Page
1 Introduction	1
2 Benefits of Centralization	1
2.1 Definition of Standoff	1
2.2 Casing Centralization and Centralizing Devices	2
3 General Discussion	3
3.1 Centralizer Types Available	3
3.2 Advantages and Limitations of Centralizer Types	7
3.3 Selecting the Type of Centralizer	8
3.4 Drag Force vs Standoff Considerations	10
3.5 Location and Number of Centralizers to Obtain a Desired Standoff	12
3.6 Estimated Drag and Torque When Using Rigid and Solid Centralizers	12
3.7 Friction Coefficients	12
3.8 Potential Benefit of Centralizer-induced Swirl	12
3.9 Centralizer Installation	15
3.10 Use of Dissimilar Materials: Casing-centralizer	18
3.11 Centralizer-formation Interactions	18
3.12 Stop Collar and Integral Collar Holding Forces	20
3.13 Centralizer Quality Control	21
3.14 Effect of Expansion Coefficient of the Stop Collar	21
3.15 Potential Impact of Centralizers on Casing String Stiffness	21
3.16 Compatibility of the Centralizers with Wellbore Fluids	22
3.17 Thermal Stability of the Centralizer Materials	23
3.18 Potential Carbon Steel and Chrome Interaction	23
3.19 Potential Generation of Gases from Materials Under Downhole Conditions	23
3.20 Centralizer Wear During Running in the Hole	23
 Figures	
1 Definition of Sandoff	2
2 Example of a Bow-spring Centralizer	3
3 Example of a Double Bow-spring Centralizer	3
4 Example of a Rigid Centralizer	4
5 Example of a Rigid Centralizer—a Slim-hole Centralizer	4
6 Example of a Rigid Centralizer	4
7 Example of Steel Spiral Solid Centralizer	5
8 Example of Steel Spiral Solid Centralizer	5
9 Example of an Integral Solid Centralizer	5
10 Example of Solid-roller Centralizer	6
11 Example of Centralizers Bonded Directly onto the Pipe	6
12 Example of Limited OD Bow-spring Centralizer	7
13 Computer Simulation for Case with Bow-spring Centralizers	9
14 Computer Simulation for Case with Rigid Centralizers	9
15 Example of the Effect of Normal Forces on Selection of Centralizer Type	10
16 Typical Swirl Angle vs Distance Away from the Centralizer	13
17 Swirl-inducing Centralizer in a Deviated, Enlarged Hole	14
18 Swirl-inducing Centralizer in an Inclined, Non-enlarged Hole	14
19 Effect of Bow-spring Centralizer in Proximity of the Device	15
20 Example of Bow Centralizer with Fins	15
21 Centralizer Installations for Casing Rotation	16

22	A Type of Rigid Centralizer Installed for Casing Rotation.	16
23	Four Centralizer Installation Patterns	17
24	Visualization of a Centralizer Embedded into the Formation	18
25	Testing of Unconsolidated Sand Under Hydrostatic Pressure.	19
26	Impact of Centralizers on Casing String Stiffness.	22

Tables

1	Example of Parameters Used in Generated Simulation	8
2	Standoff of Rigid or Solid Centralizers vs Hole Size	11
3	Holding Forces of Different Type Stop Collars.	21
4	Wear Measurements in Micrometers	23

Selection of Centralizers for Primary Cementing Operations

Acknowledgment

API Subcommittee 10 acknowledges the assistance from industry manufacturers in compiling this document. Many of them provided photos of their centralizers, and those illustrations are included in this document.

1 Introduction

The proper centralization of the casing for primary cementing has long been a critical step in quality cementing. Lack of proper centralization can lead to severe cementing problems, including lack of zonal isolation and improper casing support. The goal of this document is to provide the petroleum industry with information for three types of centralizers, their selection and application, and their advantages and limitations.

2 Benefits of Centralization

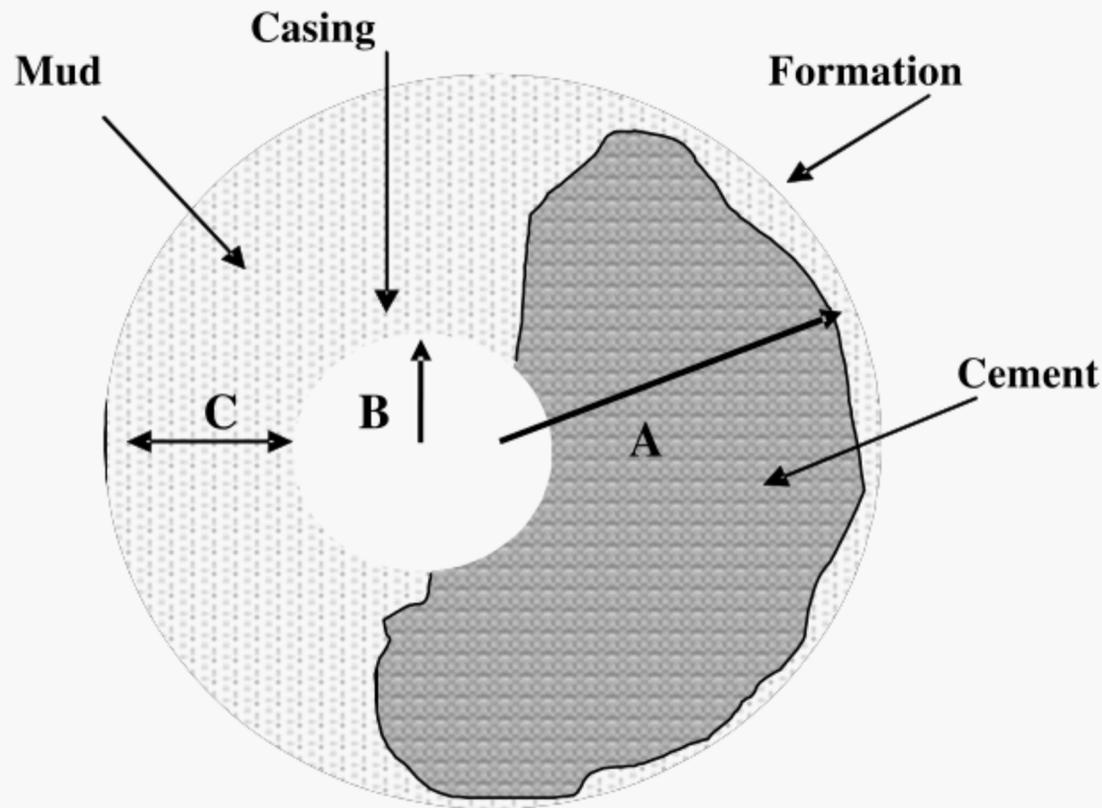
When performing primary cementing jobs, the casing should be centralized in the wellbore for three reasons:

1. to help get the casing to bottom (this includes reduction of the potential for sticking of the string);
2. to help move the casing during mud conditioning and during the cementing job;
3. to provide an optimal path for fluid flow during mud conditioning and cementing allowing for effective mud removal to achieve zonal isolation.

Field experiences, numerous large-scale experiments and computer simulations have shown that poor casing centralization can be detrimental to the cement job, particularly in narrow annuli. Therefore, a good centralization program should aim for high levels of standoff, which produces improved mud removal, particularly across critical areas of the wellbore, that is, those areas where isolation is required. It is imperative the user investigate the standoff at all points, especially between the centralizers.

2.1 Definition of Standoff

Standoff is defined by API/ISO documents (e.g. ISO 10427-2) as the smallest distance between the outside diameter of the casing and the wellbore. The standoff ratio is defined by the same documents as the ratio of standoff to the annular clearance for perfectly centered casing expressed as a percentage (%). Annular clearance for perfectly centered casing is the wellbore diameter minus the casing outside diameter divided by two. Figure 1 illustrates standoff and annular clearance.



$$\% \text{ Standoff} = \frac{C}{A - B} \times 100$$

A = Distance from center of Wellbore to Formation
 B = Distance from center of Casing to OD of Casing
 C = Smallest distance from OD of Casing to Formation

NOTE Failure to place cement completely around the casing, as portrayed in the figure, is a likely result of inadequate standoff (centralization) and results in failure to achieve isolation.

Figure 1—Definition of Standoff

2.2 Casing Centralization and Centralizing Devices

Casing centralization requires mechanical devices (centralizers) to keep the casing away from the wellbore and/or from the cased sections of the well.

Significant issues include:

1. the centralizer must provide enough load support to overcome the normal forces tending to lay the casing against the formation wall, particularly in deviated holes, horizontal holes and through doglegs;
2. enough centralizers should be used to provide good casing centralization over the needed intervals (including at points between the centralizers);
3. it is normally assumed (however not always the case) that the formation can provide enough support for the tools (minimum centralizer embedment).

3 General Discussion

3.1 Centralizer Types Available

The industry has developed three main types of centralizers: bow-spring, rigid, and solid.

3.1.1 Bow-spring Centralizer

The bow-spring centralizer is composed of flexible spring bows (heat-treated steel springs) attached to two collars. By design the bows are flexible enough to allow passage of the centralizer through restrictions but are also expected to provide standoff in enlarged hole sections. The springs come in various shapes and dimensions. The uncompressed outside diameter (OD) of a bow-spring centralizer may be much larger than the nominal hole (bit) diameter; thus, this type of centralizer can potentially “centralize” the pipe in moderately washed-out zones. Double-bow centralizers are also available. The double-bow centralizers can provide good restoring forces with low starting and running forces. Double-bow centralizers have a lesser maximum OD than conventional bow-spring centralizers and might sacrifice standoff in enlarged holes. Double-bow centralizers may also be considered semi-rigid, as will be discussed later in this document.



Figure 2—Example of a Bow-spring Centralizer

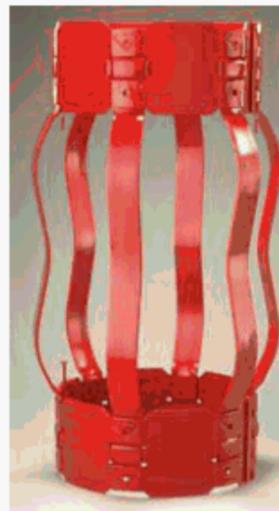


Figure 3—Example of a Double Bow-spring Centralizer

3.1.2 Rigid Centralizer

Rigid centralizers are made using non-flexible bands attached to collars. The bands are not designed to flex, and therefore, tend to maintain a constant OD. The centralizers exhibit minimal (or no) flexibility, but may have some ability to deform in hole restrictions, depending on their construction. Several types of rigid centralizers are available from manufacturers.

A subclass within the rigid centralizer category can be made for certain type centralizers. For example, the double bow-spring centralizer is considered a bow-type but may also be considered a “semi-rigid” centralizer. This is because the bows of these centralizers flex, but after small deflection, they become essentially rigid.



Figure 4—Example of a Rigid Centralizer

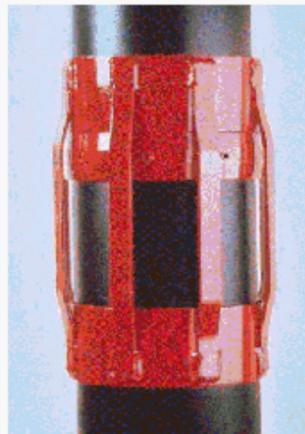


Figure 5—Example of a Rigid Centralizer—a Slim-hole Centralizer



Figure 6—Example of a Rigid Centralizer

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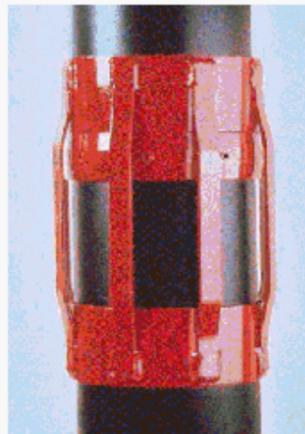


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Figure 6—Example of a Rigid Centralizer

3.1.5 Roller Type Solid Centralizer

Roller blade-type centralizers may greatly assist running the casing in extended-reach wells. The rollers have been shown to substantially reduce the drag and torque. Designs of roller centralizers are available for running the casing and also for allowing rotation of the string. Figure 10 shows a running-rotating combination.

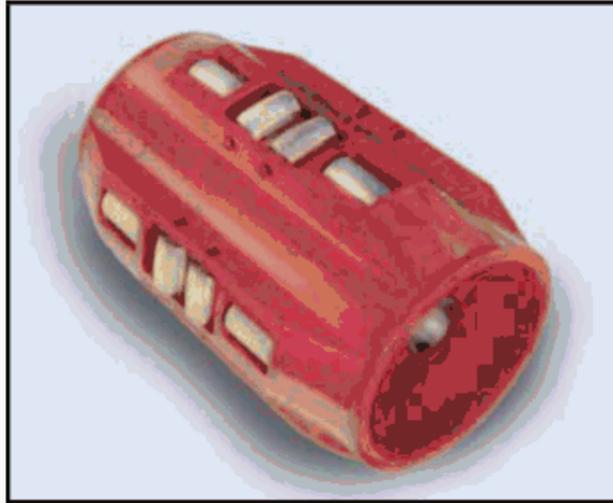


Figure 10—Example of Solid Roller Centralizer for Running and Rotating of the Casing

3.1.6 Centralizers Bonded onto the Pipe

A recently-introduced centralizer is designed for use in slim-type well configurations. The centralizers are formed and bonded directly onto the pipe. The centralizers are made from composite material consisting of carbon fibers and ceramics. Figure 11 illustrates this type of centralizer.



Figure 11—Example of Centralizers Bonded Directly onto the Pipe

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A modified bow-spring centralizer with a reduced OD and bows that meet the API specification has been introduced. The centralizer has lower starting and running forces because of the smaller OD compared to conventional bow-spring centralizers.

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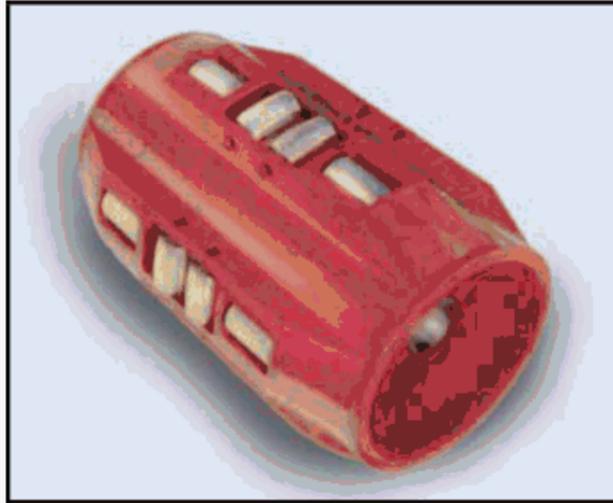


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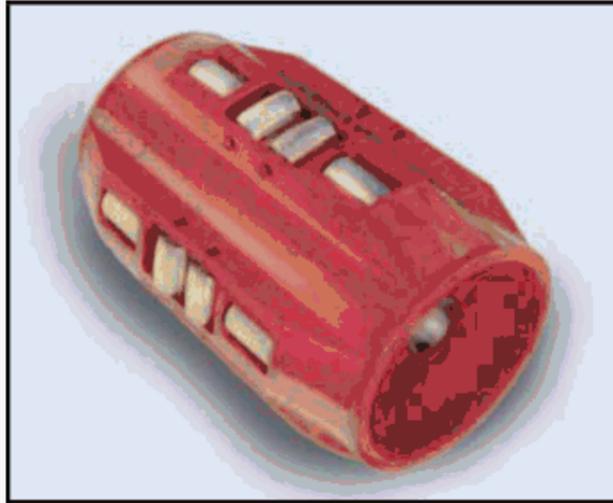


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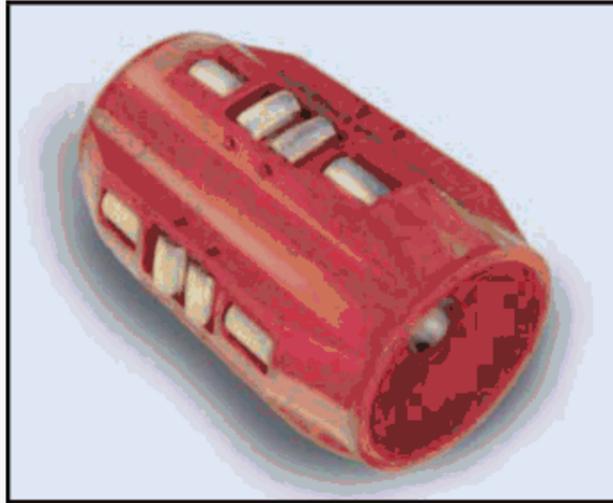


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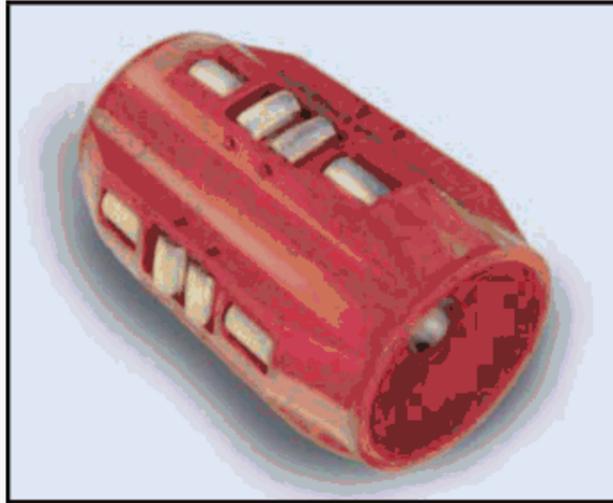


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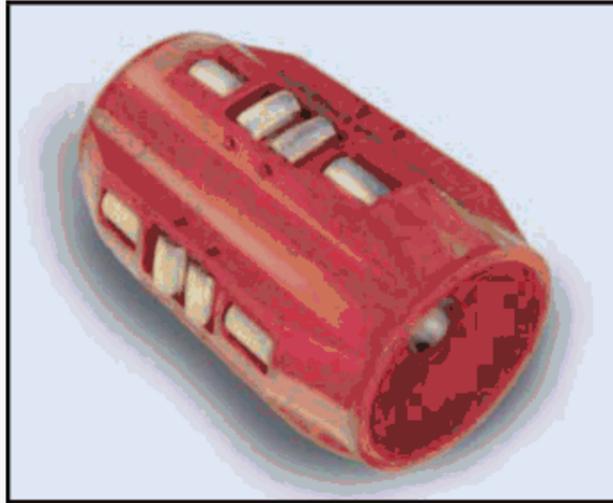


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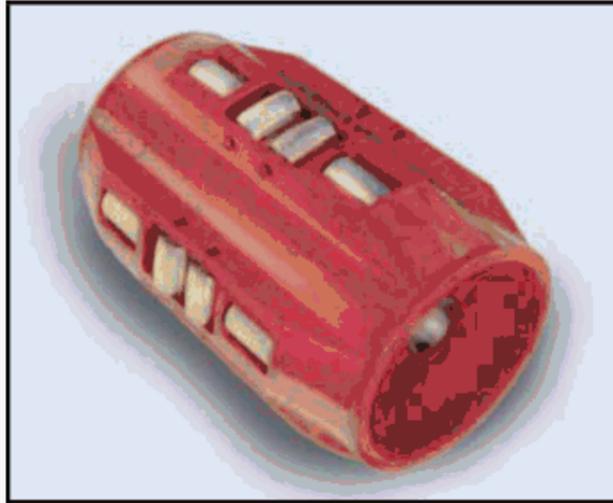


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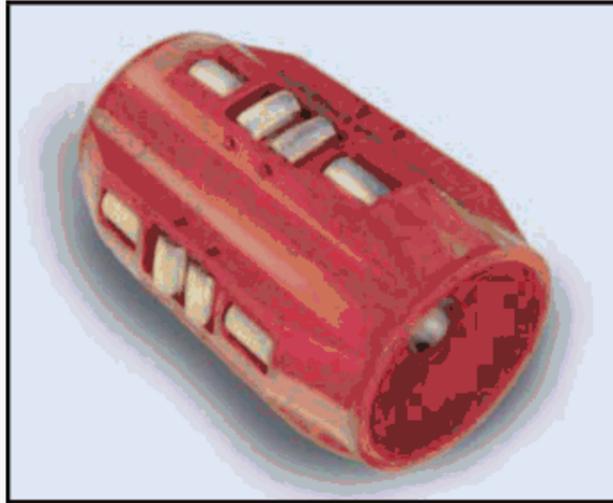


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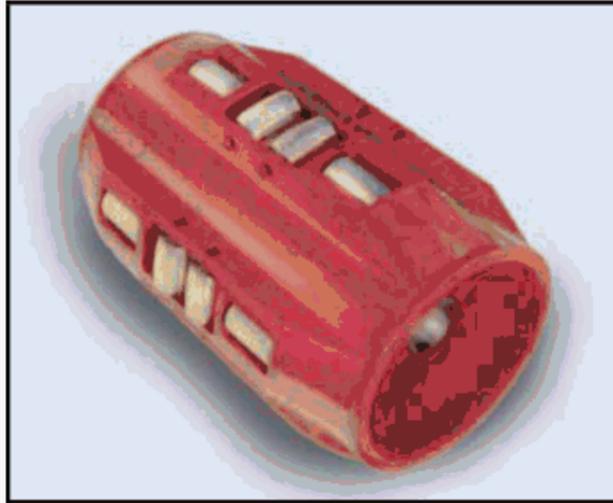


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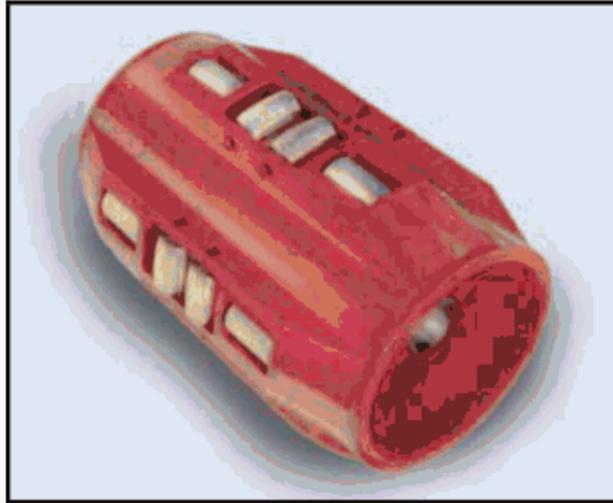


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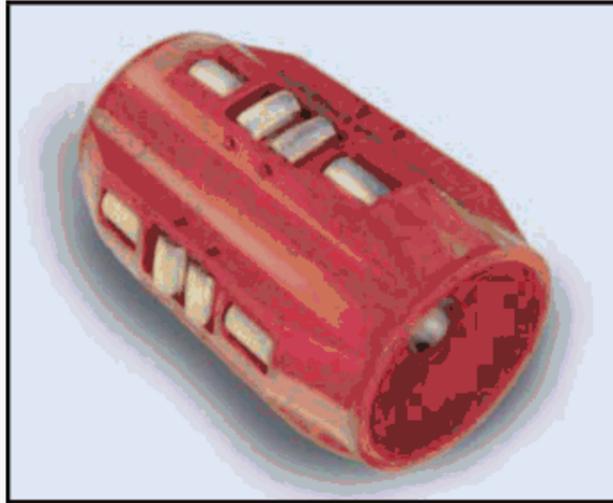


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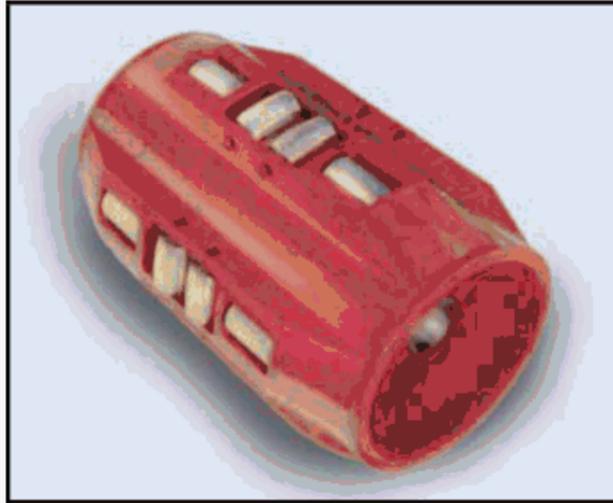


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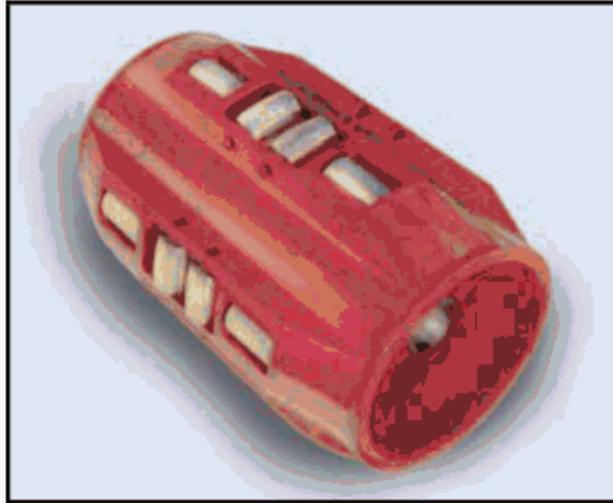


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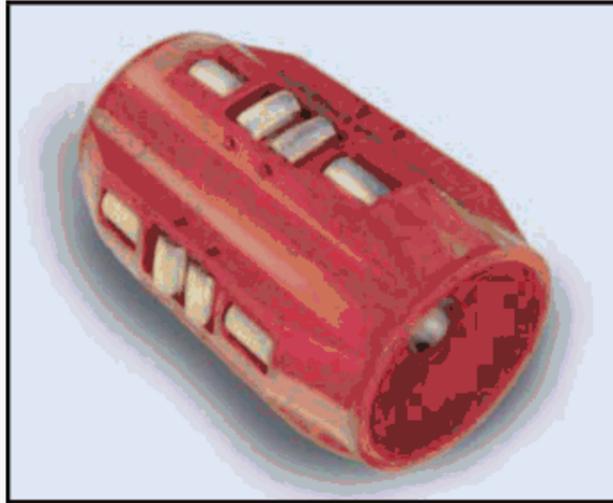


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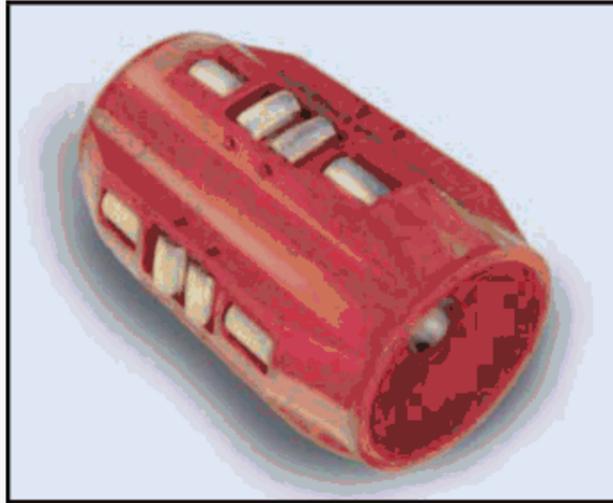


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Roller blade-type centralizers may greatly assist running the casing in extended-reach wells. The rollers have been shown to substantially reduce the drag and torque. Designs of roller centralizers are available for running the casing and also for allowing rotation of the string. Figure 10 shows a running-rotating combination.

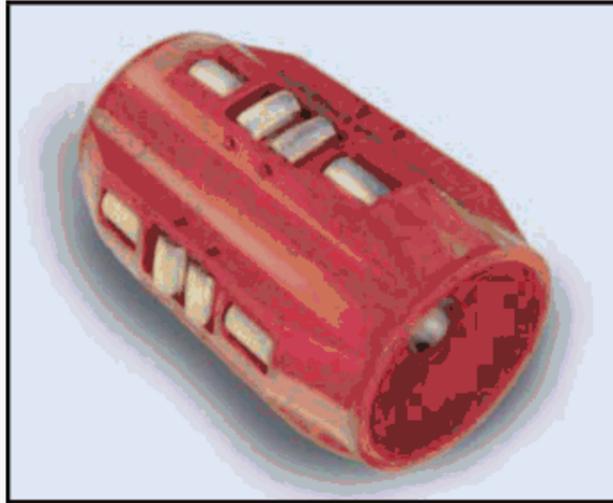


Figure 10—Example of Solid Roller Centralizer for Running and Rotating of the Casing

3.1.6 Centralizers Bonded onto the Pipe

A recently-introduced centralizer is designed for use in slim-type well configurations. The centralizers are formed and bonded directly onto the pipe. The centralizers are made from composite material consisting of carbon fibers and ceramics. Figure 11 illustrates this type of centralizer.



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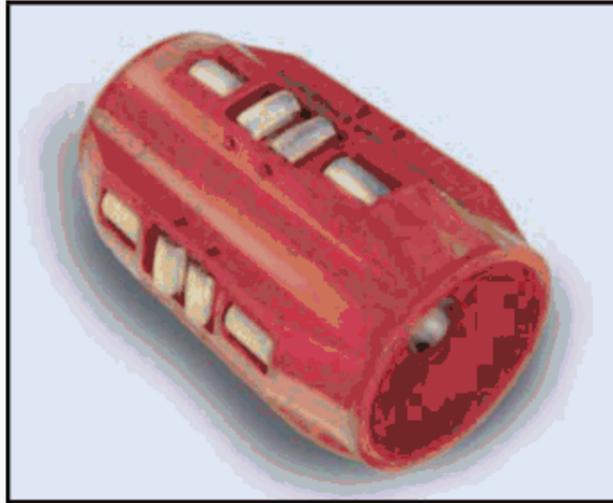


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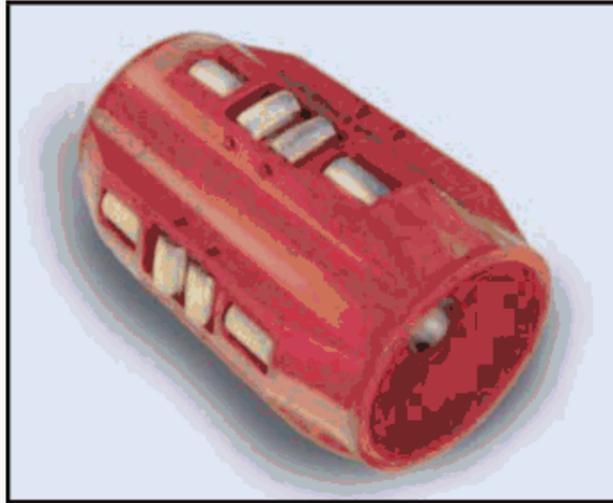


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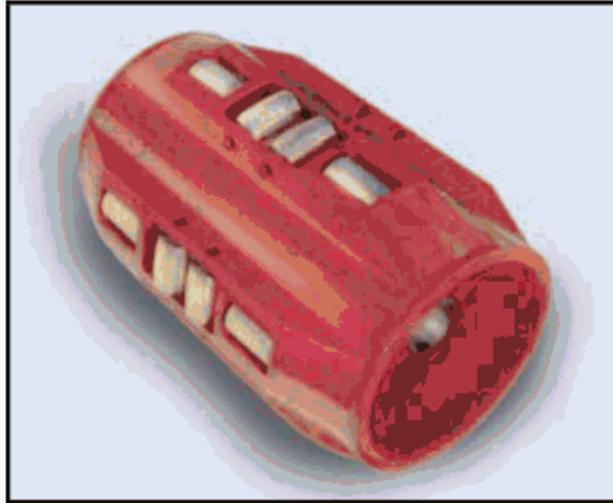


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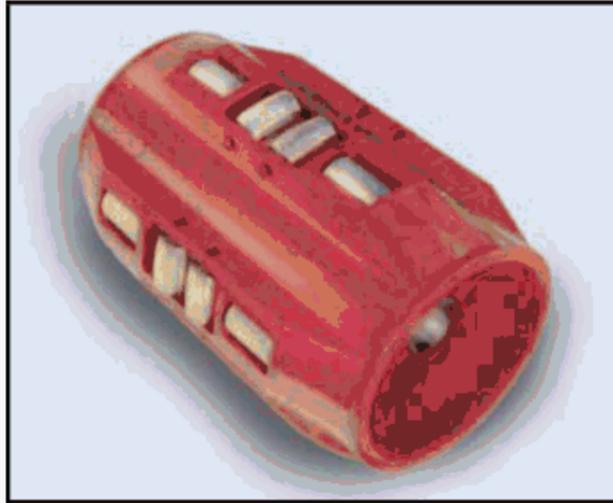


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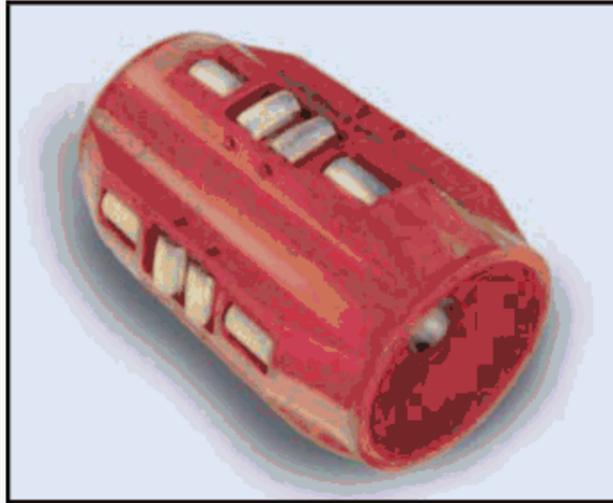


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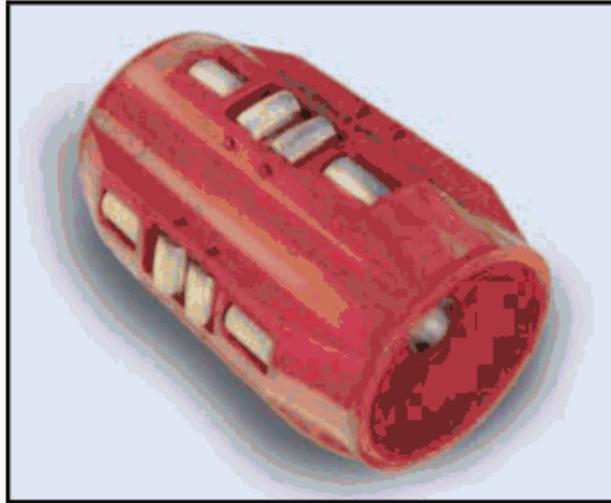


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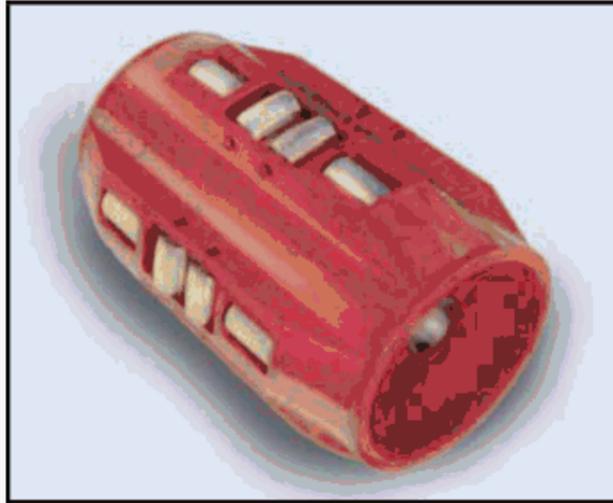


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